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# USSR Report

MATERIALS SCIENCE AND METALLURGY

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**MATERIALS SCIENCE AND METALLURGY**

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## ANALYSIS AND TESTING

UDC 669.112.227.34.001

### CRYSTALLOGRAPHY OF MULTIVARIANT MARTENSITE TRANSFORMATIONS

Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 60, No 2, Aug 85 (manuscript received 25 Jul 84) pp 223-231

YERMOLAYEV, V. A. and LIKHACHEV, V. A., Leningrad State University imeni A. A. Zhdanov

[Abstract] A mathematical apparatus is constructed for analyzing the crystallography of A $\rightarrow$ M transformations, namely the behavior and the physico-mechanical properties of crystals participating in the process, with such transformations being treated as cooperative movements of atoms from an original structure (phase) into new positions and with all possible variants of the process being covered in terms of distortions. A set of rigidly coupled A and M structures (phases) is treated as a geometric object  $S = (A, M)$  orthogonally transformable without change of mutual orientation between its elements. The mathematical-crystallographic analysis is facilitated by the introduction of an appropriate stationary system of coordinates for describing, in matrix notation, the given symmetry group and the action of its elements which yields a transformation variant with respect to an invariant structure (phase). The procedure is demonstrated on an A-phase (austenite) and its transformation into an M-phase (martensite) crystal structure. Relations are established for not only determining the number of possible new M-phase (martensite) crystal structure. Relations are established for not only determining the number of possible new M-phase grain orientations and describing them, but also for determining all possible original A-phase grain orientations transformable into a given new M-phase grain orientations and restorable from it by reverse M $\rightarrow$ A transformation. Orientation variants are defined and characterized accordingly, whereupon the apparatus for analysis is completed by introduction of four crystallographic-transformation parameters for calculation and tabulation of variants. An illustrative example considered is the reversible transformation  $m\bar{3}m \rightarrow 4/mmm$  (symmetry group  $G_A = m\bar{3}m$  with  $[G_A] = 48$ , symmetry group  $G_M = 4/mmm$  with  $[G_M] = 16$ ), with c parallel to  $a_3$  or with c not parallel to  $a_3$  but in the  $a_1a_3$ -plane.

References 4: 2 Russian, 2 Western.

[32-2415]

MAGNETIZATION REVERSAL AND DOMAIN STRUCTURE IN FERROMAGNETIC FILMS WITH COMPENSATION SURFACE

Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 60, No 2, Aug 85 (manuscript received 12 Mar 84, in final version 1 Aug 84) pp 232-242

MITSEK, A. I. and SEREBRYANIK, P. M., Institute of Metal Physics, UkrSSR Academy of Sciences

[Abstract] Films of uniaxial ferromagnetic material consisting of two sub-lattices with a compensation surface are considered, with the magnetization of one sublattice (rare-earth element) being much more temperature-dependent in the vicinity of the compensation point than that of the other (cobalt in Co-Gd alloys or iron in Fe-R.E. garnets). The magnetization reversal process and the domain structure in such a film are examined on the basis of thermodynamic analysis and the corresponding state diagram, assuming that the concentration varies linearly across the film thickness. Calculations for various positions of the compensation surface yield magnetization reversal loops, including Kerr-effect rotation from lower to upper film surface and corresponding to normal, inverse, or anomalous magnetooptic rotation. In films with multidomain structure, having large concentration gradients, magnetization reversal is effected by displacement of domain walls. Such are Co-Gd films with characteristically low magnetization and an oxidized surface layer, the latter having an "easy plane" anisotropy, in which it is reasonable to assume a horizontal domain wall near the film surface. Evolution of the compensation surface into a horizontal one, typically in a strong external magnetic field, and formation of a periodic band domain structure even without an external magnetic field, completely or partially across the film depending on the position of the compensation surface are demonstrated from the energetically favorable standpoint. The criterion here is the minimum change of energy for position of the compensation surface and the ratio of magnetostatic energy to domain wall energy corresponding to minimum film energy. References 16: 11 Russian, 5 Western (1 in Russian translation). [32-2415]

EFFECT OF ATOMIC AND MAGNETIC SHORT-RANGE ORDER ON ORDERING IN BINARY ALLOYS  
WITH B.C.C. CRYSTAL LATTICE

Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 60, No 2,  
Aug 85 (manuscript received 17 Aug 84, in final version 12 Nov 84)  
pp 262-274

VOLKOV, V. A., MASHAROV, S. I., RYBALKO, A. F. and TIMOFEYEV, N. I.,  
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[Abstract] Atomic and magnetic ordering in a substitutional binary alloy A-B with a b.c.c. crystal lattice and two magnetic sublattices is analyzed on the basis of a statistical theory. The two magnetic sublattices are assumed to coincide with the two structural ones, and the thermodynamic state of such an alloy is described by three order parameters, namely the magnetization of each sublattice and the degree of long-range order which characterizes the spacing of A and B atoms in the structural lattices. Calculations are made in the second approximation of the Kirkwood theory, extended so as to account for spin correlations in the alloy. The model includes the concentrations of both components, assuming one "magnetic" electron bound to each A or B atom, also Coulomb and exchange interactions but within the first coordination sphere only. The free energy is calculated on this basis, the first two terms corresponding to the Bragg-Williams-Gorskiy approximation without correlational interaction and the third term representing the contribution of local fluctuations in both atom and spin distributions. The equations of equilibrium are derived, and solved, with only the correlational terms of the lowest two orders (first order  $\bar{v}/kT$  ordering energy and second-order  $4J/kT$  exchange interaction energy) retained. Expressions are then obtained for the parameters of short-range order. The results reveal that correlational contributions associated with exchange interaction and thus the short-range order play an extremely important role in atomic and magnetic ordering. First of all, they make it possible for atomic order to appear in alloys with zero ordering energy, such alloys being characterized by a negative short-range order in the disordered phase. In such alloys containing transition metals a negative short-range order can form at high temperatures, causing a tendency to break up and be replaced by a state with long-range atomic order at lower temperatures. Such a long-range order does not form in alloys with positive non-zero ordering energy, even when a short-range order exists. Existence of a short-range order also appreciably alters the magnetic ordering in alloys, as well as the concentration dependence of their Curie point and of their martensite transformation temperature at concentrations near the phase transition point. References 9: all Russian.

[32-2415]

UDC: 669.234:537.322.11.001

CALCULATION OF THERMO-EMF OF PALLADIUM ALLOYS WITH IRON, COBALT AND NICKEL

Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 60, No 1, Jul 85 (manuscript received 10 Oct 84) pp 39-42

OBUKHOV, A. G., RYZHANOVA, N. V., VISHNEKOV, L. Yu., VOLOSHINSKIY, A. N. and ABRAMOVA, L. I., Metal Physics Institute, Ukrainian Science Center, USSR Academy of Sciences; Sverdlovsk Mining Institute imeni V. V. Vakhrushev

[Abstract] Results are presented from a study of the concentration dependence of thermo-EMF of the binary disordered alloys PdFe, PdCo and PdNi in the coherent potential approximation considering realistic models of component state densities taken from previous works. Calculation results are compared with experimental results and found to agree particularly well for iron-palladium alloys, though agreement is satisfactory for all alloys.

References 11: 6 Russian, 5 Western.

[17-6508]

UDC: 621.762.04

TECHNOLOGICAL DUCTILITY OF HEATED TITANIUM, COPPER AND ALUMINUM POWDER BILLETS

Kiev POROSHKOVAYA METALLURGIYA in Russian No 7, Jul 85 (manuscript received 18 Nov 83) pp 20-23

PAVLOV, V. A., LYASHENKO, A. P. and BOGUSLAYEV, V. A., Zaporozhye Machine Building Institute

[Abstract] Experiments were performed on cylindrical billets 27 mm in diameter made from electrolytic titanium powder types PTES-1 and PTEK-1, screened titanium sponge in the -0.63+0.18 fraction, copper powder type PME-1 and aluminum powder type PA-4. Billet height was equal to diameter at 90% density, increasing with decreasing density, so that the weight and diameter of the billets remained constant. The technological ductility of the heated billets was determined by upsetting them in a crank press with a smooth striker. Maximum deformation was kept just short of billet-side surface crack formation. The influence of temperature, medium surrounding the billets during heating, lubricant, sintering temperature before upsetting, initial density and powder type used was studied. The lubricants tested included a molybdenum disulfide suspension in industrial oil and colloidal graphite. The ductility of powdered titanium was found to be maximum at 900°C for PTES-1 powder sintered in a vacuum at 1100-1200°C for three hours. Both lubricants improve technological ductility, as does a decrease in porosity. Maximum ductility of copper was observed at 900°C, of aluminum at 500°C. References 3: 1 Russian, 2 Western.

[21-6508]

UDC: 621.921:532.64:669.2/8

WETTABILITY OF VARIOUS FACETS OF DIAMOND BY METALS CHEMICALLY INERT TO CARBON

Kiev SVERKHTVERDYYE MATERIALY in Russian No 4, Jul-Aug 85  
(manuscript received 15 Aug 84) pp 17-18

RAYDICH, Yu. V., PEREVERTAYLO, V. M., LOGINOV, O. B., Kiev, and  
POLYANSKAYA, N. D., Moscow: Institute of Material Science Problems,  
Ukrainian Academy of Sciences; USSR Finance Ministry

[Abstract] A study is performed of the wettability of the crystallographic faces (111) and (100) of diamond as well as graphite by metals which are chemically inert to carbon. The influence of surface roughness of the diamond crystal on contact wetting angle was also studied. Copper, silver, gold, tin and germanium with a purity of at least 99.99% were used in the studies. The wettability was determined in a vacuum of  $1 \cdot 10^{-3}$  Pa at 1100°C (1000°C for silver). No significant differences between contact wetting angles of natural and polished faces of diamonds were observed. The contact wetting angles of graphite are intermediate between those of the (111) and (100) diamond faces. All the metals studied wet the (111) face better than the (100) face. References 3: all Russian.

[22-6508]

UDC: 621.921.3:621.65

STRUCTURE OF TWO-LAYER PLATES BASED ON CUBIC BORON NITRIDE

Kiev SVERKHTVERDYYE MATERIALY in Russian No 4, Jul-Aug 85  
(manuscript received 11 May 84) pp 28-33

BOZHKO, S. A., IGNATUSH, A. I., VISHNEVSKIY, A. S. and TKACH, V. N.,  
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[Abstract] Results are presented from experiments on sintering of cubic boron nitride powder on substrates of tungsten-free hard alloy based on titanium carbonitride or chromium carbide. Optical and scanning electron microscopy methods were used in the metallographic studies. X-ray microanalysis was performed. Studies of the grain composition of CBN powder after exposure to high pressure showed that compacting is accompanied by breakup of the grains of large fractions. Application of 7.7 GPa pressure to initial powders with grain size 60/40 crushed about 70% of the grains to 3/2-1/0. Some 60% of the particles of grain size 14/10 powder were also crushed, while a 3/2 fraction powder did not change. The physical and chemical interaction of CBN powder with hard alloy components in the substrate was found to determine the structure and composition of the cutting layer and the width and composition of the transition zone.

References 9: 7 Russian, 2 Western.

[22-6508]

UDC: 541.124.16:546.26.162:543.87

OXIDATION OF GRAPHITE AND DIAMOND SYNTHESIZED FROM IT BY DYNAMIC METHOD

Kiev SVERKHTVERDYYE MATERIALY in Russian No 4, Jul-Aug 85  
(manuscript received 4 May 84) pp 34-36

OGORODNIK, V. V., PUGACH, E. A., IVAS'KEVICH, Ye. V., MARKOV, Kiev,  
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[Abstract] Studies were preformed to determine the temperature at which oxidation begins, its rate and extent, as well as the phase and structural transformations accompanying the process of oxidation of graphite of various grades, both natural and artificial, as well as synthetic diamonds produced from the graphite. The diamonds were synthesized by a dynamic method using a graphite mixture which was compacted, heated, sintered, then exposed to a shock wave, and then the diamonds were extracted chemically. It was found that the degree of oxidation of graphite depends on its particle size composition and quantity of impurities, with the activation energy being somewhat higher for graphite than for diamond. The resistance of diamonds to oxidation is lower than that of the graphite from which the diamonds were synthesized. References 8: 7 Russian, 1 Western.

[22-6508]

UDC: 621.921.26

STRUCTURE AND CERTAIN PROPERTIES OF SILICON NITRIDE POWDERS

Kiev SVERKHTVERDYYE MATERIALY in Russian No 4, Jul-Aug 85  
(manuscript received 6 Jul 84) pp 37-39

GOLUBYAK, L. S., KISLYY, P. S., KULICH, V. G. and ZALIZNYAK, V. T., Kiev,  
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[Abstract] A study is presented of the chemical and particle size composition of silicon nitride powders obtained by nitriding silicon in a furnace and by the method of self-propagating high-temperature synthesis. The structure of the powder particles is also studied by scanning microscope. Studies showed that the morphology of individual grains was independent of the method of their production. X-ray phase analysis of powders produced by both methods reveals traces of the  $\alpha$  phase and beta  $\text{Si}_3\text{N}_4$ , but no free silicon, probably as a result of the shielding effect of the nitride envelope of the large particles. The technological suitability of various batches of the powder varies. The methods now used for synthesis of silicon nitride do not provide for full nitriding of the initial silicon powder. Silicon particles larger than  $10 \mu\text{m}$  interact with the nitrogen only on their surfaces, the core of the particles remaining unreacted. Particles of  $10 \mu\text{m}$  or larger should be segregated and further ground before nitriding.

References 5: 2 Russian, 3 Western.

[22-6508]

## RESISTANCE OF VT22 TITANIUM ALLOY TO CYCLIC CRACKING

Kiev PROBLEMY PROCHNOSTI in Russian No 7, Jul 85  
(manuscript received 9 Oct 84) pp 20-23

BOYTSOV, B. V., GUSENKOVA, A. A., PONOMAREV, A. S. and PETUKHOV, Yu. V.,  
Moscow Aviation Institute

[Abstract] An experimental study of the VT22 titanium alloy was made for determining its resistance to cracking under cyclic loading and its mode of fracture. Specimens of this alloy were produced by hammering round bar stock into 10 mm thick and 120x100 mm<sup>2</sup> large plates, whereupon two holes were drilled for mounting in a Servotest fixture and a notch was cut symmetrically between them as crack initiator. All specimens were heat treated as follows: heating to 850°C - holding at 850°C for 1 h - cooling in furnace to 750°C - holding at 750°C for 2-3 h - cooling in air. One lot was then reheated to 630°C and air-cooled after having been held at that temperature for 4 h (ultimate strength 1050-1150 MPa). Another lot was then reheated to 600°C and air-cooled after being held at that temperature for 4 h (ultimate strength 1150-1250 MPa). Both lots of specimens were tested in an MTS 50-ton universal electrohydraulic machine for cracking rate and toughness, the load being varied stepwise with increasing crack length L and the number of load cycles N being increased correspondingly. The cycling frequency was set at 6.6 Hz. and the load cycle asymmetry was maintained constant at 10%. The maximum load varied from 4900 N to 14,700 N depending on the crack length. An evaluation of the data, with the stress intensity coefficient K calculated according to a proven empirical formula valid for crack lengths within the  $L = (0.2-0.7)B$  range ( $B = 100$  mm - plate dimension in the direction of cracking), revealed a close fit with the Paris equation  $dL/dN = C\Delta K^n$ . Curve fitting by the method of least squares has yielded the material constants  $C = 1.7 \cdot 10^{-7}$ ,  $n = 2.38$  for VT22 alloy reheated to 630°C and  $C = 2.4 \cdot 10^{-7}$ ,  $n = 2.12$  for VT22 alloy reheated to 600°C. The high correlation coefficient  $R_N = 0.94-0.95$  makes it possible to approximate all of the data with the single equation  $dL/dN = 5.17 \cdot 10^{-8} \Delta K^{2.65}$  within the range between threshold and breaking stress intensities for both lots, the difference in heat treatment affecting only their toughness: 81.5 MPa after reheat to 630°C and 65.5 MPa after reheat to 600°C. References 3: 2 Russian, 1 Western.

[18-2415]

TEMPERATURE DEPENDENCE OF CRACKING RESISTANCE OF GaAs SINGLE CRYSTALS

Kiev PROBLEMY PROCHNOSTI in Russian No 7, Jul 85  
(manuscript received 28 Nov 83) pp 23-26

DRANENKO, A. S. and NOVIKOV, N. N., Kiev University

[Abstract] An experimental study of GaAs single crystals was made for determining the temperature dependence of their resistance to cracking in the (111)-planes and (111)-planes (not equivalent in polar compounds of the sphalerite form). Specimens of GaAs crystals, doped with Te to a charge carrier concentration of  $6 \cdot 10^{18} \text{ cm}^{-3}$ , were grown by the Czochralski method with a growth dislocation density of the order of  $10^4 \text{ cm}^{-2}$  in addition to boundary dislocations. The specimens were tested for sudden crack propagation, some as grown and some after being annealed at  $400^\circ\text{C}$  under vacuum for 2 h. They were tested with a pyramidal microindenter, their cracking resistance being characterized by the critical stress intensity at the crack tip and its dependence on the length of radial cracks within the indenter-specimen contact zone (crack length normalized to size of the impression). The data reveal that the stress intensity coefficient, calculated according to Evans-Charles and Marsh relations, is independent of the load over the 80-200 g range at any temperature up to  $500^\circ\text{C}$  at least, that the stress intensity coefficient dips slightly to a minimum at  $200^\circ\text{C}$  (111-planes) or  $300^\circ\text{C}$  (111-planes) and then increases sharply with rising temperature for untreated crystals but rises slightly and then remains constant above  $100^\circ\text{C}$  for annealed crystals, and that the mean number of cracks around the impression remains constant up to  $300^\circ\text{C}$  (111-planes and 111-planes) for untreated crystals but up to  $350-400^\circ\text{C}$  for annealed crystals before decreasing as the temperature rises further. The temperature of cold shortness in both planes is estimated by extrapolation to the temperature axis (abscissas - zero number of cracks):  $580^\circ\text{C}$ . References 12: 6 Russian, 6 Western (2 in Russian translation).

[18-2415]

X-RAY STRUCTURAL EXAMINATION OF FRACTURES UNDER CYCLIC IMPACT LOAD

Kiev PROBLEMY PROCHNOSTI in Russian No 7, Jul 85  
(manuscript received 20 Dec 83) pp 32-34

KLEVTSOV, G. V., BOTVINA, L. R. and ZHIZHERIN, A. G., Frunze Polytechnic Institute

[Abstract] The behavior of grade-45 steel (0.48% C) under cyclic impact loading was studied by x-ray structural examination of fractures. Specimens

in the form of bars 165 mm long with rectangular  $12 \times 17 \text{ mm}^2$  cross-section were first annealed at  $850^\circ\text{C}$  for 1 h and then tested in a DSO-150 machine for pure flexure under cyclic impact at a repetition rate of 450 per minute. The tests were performed at two load levels corresponding to a nominal stress of 285 MPa and 410 MPa, respectively. Structural changes in the material were monitored on x-rays obtained with a DRON-1.5 diffractometer and a CoK $\alpha$  source. The results reveal an initially steady crack propagation at a constant rate, followed by an accelerating crack propagation beyond the critical crack length (4 mm under nominal stress of 285 MPa, 3 mm under nominal stress of 410 MPa). They also reveal two zones of plastic deformation, cyclic deformation and monotonic deformation, whose depths under the surface increases first slowly with increasing crack length, then sharply within the range of critical crack length, and continue to increase slowly again (410 MPa) or remain constant (285 MPa) as the crack propagates farther. These trends correlate with corresponding changes in the width of the (220) diffraction line. While cyclic impact loading thus has some common features with fatigue loading, it differs from the latter by induction of strain hardening within the region of pure flexure. References 6: all Russian.  
[18-2415]

UDC 669.14:620.17

#### EFFECT OF SHORT COMPRESSIVE OVERLOADS ON CRACKING RESISTANCE OF METAL IN HOUSING PARTS OF STEAM TURBINES UNDER CONDITIONS OF CREEP

Kiev PROBLEMY PROCHNOSTI in Russian No 7, Jul 85  
(manuscript received 14 Aug 84) pp 38-43

GLADSHTEYN, V. I., All-Union Institute of Heat Engineering imeni F. I. Dzerzhinsky, Moscow, and OSASYUK, V. V., Institute of Strength Problems, UkrSSR Academy of Sciences, Kiev

[Abstract] An experimental study was made on the design and performance of housing parts for steam turbines, namely of the effect of cyclic compressive overloads on the cracking resistance of the housing metal under a continuous static load with creep. It had already been established that, while tensile overloads tend to decrease the average crack propagation rate, compressive overloads tend to increase it. Tests were performed on specimens of two steels: cast pearlitic 15Kh1M1FL for 160-800 MW turbines operating with live steam at  $545-565^\circ\text{C}$  and austenitic KhN35VT steel for the first Soviet-made turbine operating with live steam at  $650^\circ\text{C}$ . The specimens were cylindrical,  $D = 26 \text{ mm}$  in diameter (15Kh1M1FL) and  $D = 18 \text{ mm}$  in diameter (KhN35VT), with narrow (up to 0.05 mm wide) and deep (0.4D-0.6D) circumferential notches. They were loaded as follows: heating to  $300^\circ\text{C}$  with simultaneous compression to a stress level not lower than  $1.1\sigma_0^{0.2}$  - holding under these conditions for 0.25 h - unloading with simultaneous heating to the maximum temperature ( $565^\circ\text{C}$  for 15Kh1M1FL steel,  $650^\circ\text{C}$  for KhN35VT steel) - static loading at that temperature for various lengths of time - unloading and cooling to  $300^\circ\text{C}$ . This cycle was repeated till full rupture of specimens

occurred. Their cracking resistance was evaluated in terms of the stress intensity coefficient at fracture of steel within the danger zone after 100 h of static loading. The results suggest three likely competing aftereffects of compressive overloads: 1) buildup of an oriented microstress field by interaction of dislocations and barriers; 2) increased number of dislocations and decreased length of mean free path; 3) "loosening" of the crystal lattice with increased concentrations of vacancies and interstitial atoms. Regardless of the mechanism, austenitic steel (KhN35VT) was found to be much more sensitive to compressive overloads than pearlitic steel (15Kh1M1FL). Such overloads can reduce the static strength of turbine housing parts made of these steels with an initial crack. Shortening the interval between successive overloads lowers the cracking resistance of both steels, unless that interval exceeds 150 h for 15Kh1M1FL steel at 565°C or 2400 h for KhN35VT steel at 650°C. References 10: 4 Russian, 6 Western (1 in Russian translation). [18-2415]

UDC 621.539.43.001.24

#### DEPENDENCE OF SHORT-BASE FATIGUE OF AUSTENITIC STEELS AND THEIR WELDED JOINTS ON STATIC LOAD COMPONENT

Kiev PROBLEMY PROCHNOSTI in Russian No 7, Jul 85  
(manuscript received 8 Oct 84) pp 50-55

GIGINYAK, F. P., BASHTA, V. V., ULIN, V. P., TIMOFEEV, B. T. and  
MOZHAROVSKAYA, T. N., Institute of Strength Problems, UkrSSR Academy of  
Sciences

[Abstract] A study of 08Kh18N9 steel and welded joints of it was made for determining their fatigue strength under a short-base cyclic stiff load at 650°C and its dependence on the static load component at the peak level. Tests were performed on solid cylindrical specimens 10 mm in diameter and 32 mm in gage length. Theoretical calculations of this fatigue strength on the basis of a scalar parameter as kinetic criterion of fracture, namely  $(1 - w_f^i - w_s^i)^{r+1} \leq R$  ( $i = N_b$ ), reveal a close agreement with the test results. This criterion has been developed at the Institute of Strength Problems:  $w_f$  and  $w_s$  are respectively the fatigue component and the static component of defectiveness in the  $i$ -th cycle,  $R = (\sigma/\sigma_u)^{n+1}$  ( $\sigma_u$  - ultimate strength), and  $N_b$  is the base or number of cycles till fracture. This criterion is in this case more satisfactory than its variant  $(1 - \Delta w_f - \Delta w_s - w^i)^{r+1} \leq R$  ( $i = N_b$ ) with  $\Delta w = w^{i+1} - w^i$ , which underestimates the life. References 8: all Russian.

[18-2415]

## RESISTANCE OF ALUMINUM ALLOY TO DEFORMATION AT HIGH STRAIN RATES

Kiev PROBLEMY PROCHNOSTI in Russian No 7, Jul 85  
 (manuscript received 27 Aug 84) pp 56-57

ASTANIN, V. V., Institute of Strength Problems, UkrSSR Academy of Sciences,  
 Kiev

[Abstract] Previous high-speed tests, by a method specially developed at the Institute of Strength Problems for loading sheet metal in compression impact, had yielded data on the resistance of D16M aluminum alloy to deformation at strain rates up to  $2.25 \cdot 10^5 \text{ s}^{-1}$ . A subsequent study of this material was made with the range of strain rates expanded to  $6.6 \cdot 10^5 \text{ s}^{-1}$ . The test specimens were 1 mm thick and had 2 mm wide slots between 1 mm wide teeth. The maximum impact velocity was 803 m/s. The data indicate that the resistance, after first increasing linearly with the strain rate  $\dot{\epsilon}$  and reaching the 2.5 GPa level at  $\dot{\epsilon} = 2.25 \cdot 10^5 \text{ s}^{-1}$ , increases to 6.8-7.0 GPa at  $\dot{\epsilon} = 4.3 \cdot 10^5 \text{ s}^{-1}$  when the material is strained to the  $\dot{\epsilon} = 0.5$  point. The resistance then remains constant at that level as the strain rate is increased further. The data are also useful for estimating the temperature of compression impact on D16M sheet (density  $\rho = 2.8 \cdot 10^3 \text{ kg/m}^3$ , heat of fusion  $Q_m = 0.32 \cdot 10^6 \text{ J/kg}$ , specific heat  $c_v = 0.9 \text{ kJ/(kg} \cdot ^\circ\text{C)}$ ,  $\sigma = 7 \text{ GPa}$ ):  $T = (Q_0 - Q_m)/\rho c_v = (\sigma \dot{\epsilon} - \rho Q_m)/\rho c_v (\dot{\epsilon} = 0.5)$ . The author thanks G. V. Stepanov for discussion of the results and helpful comments.

References 6: 5 Russian, 1 Western (in Russian translation).

[18-2415]

## DEPENDENCE OF PRONENESS OF STEEL TO DELAYED FRACTURE AFTER HIGH-TEMPERATURE THERMOMECHANICAL TREATMENT ON ITS DEGREE OF PURITY

Kiev PROBLEMY PROCHNOSTI in Russian No 7, Jul 85  
 (manuscript received 1 Mar 83) pp 58-61

GUREVICH, Ya. B., KNYAZEVA, V. R., SARRAK, V. I. and FILIPPOV, G. A.,  
 Central Scientific Research Institute of Ferrous Metallurgy, Moscow

[Abstract] An experimental study of 30KhGSN2A steel was made for determining the dependence of its proneness to delayed fracture after high-temperature thermomechanical treatment and of its toughness on its initial degree of purity as well as on the degree of austenite recrystallization during such treatment. Three batches of this steel were tested, one from an industrial ladle and two from a laboratory ladle with respectively 0.006 wt.% and 0.015 wt.% of phosphorus added. They were all treated as follows: heating to 950°C and rolling to 15-30-40 % deformation. After

been subsequently quenched in water, some specimens were tempered at 100°C for one hour and some were not. With a circular notch of 1 mm radius, all specimens were tested in an Instron machine for delayed fracture. This was done by application of a concentrated load deforming the specimens at a rate of 0.5 cm/min. The stress intensity coefficient was determined on specimens 55 mm long and 10x3 mm<sup>2</sup> in cross-section with a sharp notch and a preinduced 1.5-2 mm long fatigue crack. The data were evaluated so as to indicate the dependence of proneness to delayed fracture after quenching on the percent deformation during thermomechanical treatment as well as the dependence of proneness to delayed fracture and of toughness after quenching and after low-temperature tempering on the phosphorus content. Three possible causes of this dependence are suggested: 1) high phosphorus concentration at grain boundaries of the original austenite; 2) change in the level of residual internal microstresses as a result of martensite transformation; 3) different deviations of crack propagation trajectories from rectilinearity depending on the grain size encountered and especially large deviations caused by large grains. It is recommended that high-purity steel be used for high-temperature thermomechanical treatment so as to ensure not only higher strength but also better reliability and longer life. References 9: 6 Russian, 2 East German, 1 Western (in Russian translation).

[18-2415]

UDC: 669.187.2:669.15.25-620.18:539.56

#### STUDY OF COLD SHORTNESS OF HIGH-MANGANESE STEELS

Kiev PROBLEMY SPETSIALNOY ELEKTROMETALLURGII in Russian No 3, Jul-Aug-Sep 85 (manuscript received 8 Aug 84) pp 35-38

PONOMARENKO, V. P., SHVARTSER, A. Ya., STOYKO, V. P. and STROGANOVA, G. V., Donets Polytechnical Institute

[Abstract] A study is presented of cold shortness of high-manganese steel type 70G7Kh4N2M. The steel has an austenitic structure after electric slag remelting without heat treatment, with high impact toughness and good surface hardenability. Cold shortness was determined both immediately after electric slag remelting and induction melting, and after heat treatment by hardening in water from 1100°C. Phase transformations were found not to be the reason for the cold shortness of the steels. Previous works suggesting that high manganese steels undergo viscous fracture at all test temperatures were also not confirmed. FeO particles were not found to decrease the impact toughness at below-freezing temperatures. The decrease in ductility of high manganese steels at low temperatures is explained on the basis of dislocation theory, according to which various types of inclusions serve as sites of accumulation of dislocations. Decreasing test temperature reduces the mobility of dislocations, thus reducing metal ductility. References 6: all Russian.

[15-6508]

UDC: 620.179.15

## MEASUREMENT OF DENSITY OF SOLIDS BY BACK SCATTERING OF X-RADIATION

Moscow DEFEKTOSKOPIYA in Russian No 8, Aug 85  
(manuscript received 8 May 84; in final form 22 Nov 84) pp 52-59

GROSHEV, V. Ya. and ZABRODSKIY, V. A., Scientific Research Institute of Electron Introsopy, Tomsk

[Abstract] A study is made of the possibility of testing the density of materials based on the back scattering of low energy radiation, on the example of the use of the radiation of an x-ray tube. The depth of testing of material density for materials with low atomic number is as great as 2 - 3 cm for radiation with an energy of not over 30 keV. The use of x-ray tubes greatly simplifies the problems of transportation and storage of radiation sources. The method suggested is possible only if the change in effective attenuation coefficients with a change in effective atomic number of the substance is equal or proportional. Given equivalent measurement accuracy, the requirements for stability of the anode voltage of a Bremsstrahlung tube are greater than those for an x-ray tube. The method suggested was used in the development of the low energy x-ray densitometer. The device was tested using specimens of a two-component mixture of epoxy resin and aluminum oxide, for which there is no correlation between effective atomic number and density. Error was found to be 1.5 - 2 times less than for density measurement by the use of Bremsstrahlung. References 14: 12 Russian, 2 Western.

[246-6508]

UDC: 620.179.15

## STATIC MODELING OF ERROR IN RADIATION ABSORPTION MEASUREMENT DEVICES

Moscow DEFEKTOSKOPIYA in Russian No 8, Aug 85  
(manuscript received 16 Apr 84) pp 59-65

KREYNDLIN, I. I., MATVEYEV, L. V. and SOBOLEV, I. A.

[Abstract] An analysis is presented of the errors of radiation measurement instruments by statistical modeling, consisting of the following main stages: creation of a mathematical model of the instrument; development of a modeling algorithm; programming of a computer; and analysis of modeling results with, when necessary, refinement of the mathematical model and computational algorithm. The method is capable of considering all of the major components of measurement errors characteristic for radiation instruments: statistical, background, hardware, and methodologic errors. A radiation densitometer was modeled on an Elektronika D3-28 computer. Statistical modeling was found to be quite promising for the study, optimization and development of scientifically well-founded designs for radiation instruments. References 9: 8 Russian, 1 Western.

[246-6508]

UDC: 620.179.15

DETERMINATION OF WEAR RESISTANCE OF HARD ALLOY TOOL MATERIALS BY POSITRON ANNIHILATION

Moscow DEFEKTOSKOPIYA in Russian No 8, Aug 85  
(manuscript received 5 Apr 84; in final form 24 Dec 84) pp 81-82

VOROBYEV, S. A., DEMENTYEV, F. A., KOZHEVNIKOV, D. V., NESTERNEKO, V. P. and POGREBNYAK, A. D., Tomsk Polytechnical Institute imeni S. M. Kirov

[Abstract] The positron annihilation method is of interest as a nondestructive method of predicting the wear resistance of hard alloy tools. The sensitivity of the method to defects in metals and alloys such as vacancies, dislocations and pores is well known. Hard-alloy cutting tools were tested on a model 163 lathe at constant temperature and cutting speeds of 40, 60 and 80 m/min with a feed rate of 0.2 mm/rev and cutting depth of 2 mm. The positron annihilation method was shown to be usable to predict the life of hard-alloy tools for working of specific materials under known cutting conditions.

References 3: all Russian.  
[246-6508]

UDC: 620.17918:621.317.7

POTENTIAL TESTS FOR CONTACTLESS CAPACITIVE DEFECTOSCOPY METHODS

Moscow DEFEKTOSKOPIYA in Russian No 8, Aug 85  
(manuscript received 16 May 84) pp 88-93

PRONIN, V. P., Saratov Agricultural Institute imeni N. I. Vavilov

[Abstract] Simple, reliable test structures are suggested providing a distribution of potential which is near sinusoidal and allowing estimation of the resolution of microprobes of up to twenty lines per millimeter. The tests provide near-harmonic uniform distribution of potential in a plane tangent to the conductor and allow effective utilization of the mathematical apparatus developed earlier for estimation of metrologic parameters of capacitive probes used for contactless determination of defects in dielectric and semiconductor layers. Several switching and supply modes are implemented, the selection of which allows testing of the resolution of probes down to 20 lines/mm as well as estimation of the reaction of the entire system to individual short or extended potential heterogeneities. References 6: 5 Russian, 1 Western.  
[246-6508]

/9835

## COMPOSITE MATERIALS

UDC: 669.018.9:669.295

### STUDY OF COMPOSITE MATERIALS WITH TITANIUM ALLOY-BASED MATRIX

Moscow IZVESTIYA AKADEMII NAUK SSSR: METALLY in Russian No 4, Jul-Aug 85  
(manuscript received 28 Sep 83) pp 159-162

BAKARINOVA, V. I., MESHCHERYAKOV, V. N., NARTOVA, T. T. and TARASOVA, O. B.,  
Moscow

[Abstract] A study is presented of the possibility of creating a heat-resistant composite material by the use of a matrix consisting of a Ti-Al-Zr-W alloy, as well as the interaction at the interface between the nonmetallic fiber and the titanium alloy. A 12 kg ingot of the alloy was produced by arc melting of an electrode pressed from TG-100 titanium sponge with A-999 aluminum and iodide zirconium, tungsten was provided as a Ti-W master alloy prepared by powder metallurgy methods. The ingot was forged at 900-1100°C into 20 x 20 mm bars, which were then used to produce foil 0.09-0.1 mm thick. Boron reinforcing fibers with and without a silicon carbide coating 2.3 micrometers thick, plus silicon carbide fibers coated with zirconium carbide and hafnium carbide 1 micrometer thick, were used as the reinforcement. Composite materials were prepared by vacuum diffusion welding of faggots in special press molds. Studies of the interaction at the fiber-matrix interface indicated that boron fibers coated with silicon carbide were superior for reinforcement of the titanium alloy. The mechanical properties of the composite were determined. Short-term strength at 800°C was 170-220 MPa.

References 7: 5 Russian, 2 Western.

[23-6508]

UDC: 669.782.65

### KINETICS OF GRAPHITIZATION OF CARBON FIBER IN NICKEL-BASED COMPOSITE

Kiev POROSHKOVAYA METALLURGIYA in Russian No 7, Jul 85  
(manuscript received 25 Oct 84) pp 72-77

DUDAREV, Ye. F. and TUROVETS, L. A., Siberian Institute of Physics and Technology

[Abstract] The task of this work was to determine the patterns and mechanism of activated graphitization of carbon fiber in a nickel-based

composite. The material was produced with carbon fiber heat-treated at 1850 K and coated with nickel first chemically, then electrolytically. Specimens of the composite material were annealed in a vacuum of  $133 \cdot 10^{-5}$  Pa at temperatures from 1073 to 1373 K, so that oxygen did not influence the activated graphitization of the fibers. Spectral analysis indicated that nickel truly penetrated into the carbon fibers, with the moment that its concentration began to increase in the fibers coinciding with the beginning of restructuring of the fibers to graphite. X-ray spectral analysis, however, showed no accumulation of nickel in the carbon fibers. Nickel is insoluble in the graphite lattice and can penetrate into the carbon fibers only along interfaces such as the boundaries of fibers and, after activated graphitization--the boundaries of graphite grains. Segregation of nickel on the fiber interfaces breaks down bonds between fibers and forms graphitization centers, followed by surface diffusion of carbon. A kinetic equation is derived to describe the process, and the results of its application agree well with experimental data. References 12: 6 Russian, 6 Western.  
[21-6508]

/9835

CORROSION

UDC: 669.26:620.193.01

VARIATION IN RATE OF DISSOLUTION OF CHROMIUM AS FUNCTION OF POTENTIAL

Moscow ZASHCHITA METALLOV in Russian Vol 21, No 4, Jul-Aug 85  
(manuscript received 14 Jun 84) pp 515-519

KNYAZHEVA, V. M., BABICH, S. G. and DEMBROVSKIY, M. A., All-Union Inter-branch Scientific Research Institute of Protection of Metals from Corrosion; Scientific Research Institute of Physics and Chemistry imeni L. Ya. Karpov

[Abstract] The task of this work was to use new, improved experimental techniques to establish the variation in steady chromium dissolution rate as a function of potential and compare it with results derived earlier. Great attention was paid to determination of the kinetics of dissolution of chromium at various potentials in order to obtain steady rate values. This was done using a special electrochemical cell allowing sampling of the solution without breaking the polarization circuit. The results agree satisfactorily with those of previous works obtained by less sensitive methods. References 6: all Russian.

[14-6508]

UDC: 620.193.41

INFLUENCE OF TEMPERATURE AND RATE OF MOVEMENT OF 92% SULFURIC ACID  
ANODIC BEHAVIOR OF STAINLESS STEELS

Moscow ZASHCHITA METALLOV in Russian Vol 21, No 4, Jul-Aug 85  
(manuscript received 16 Apr 84) pp 520-524

KUZUB, V. S., KRIKUN, V. P., NOVITSKIY, V. S. and KHRISTENKO, T. A., State Methanol Scientific Research and Planning Institute

[Abstract] The anodic behavior of steels types 12Kh18N10T, 10Kh17N13M2T, 08Kh22NM6T and 08Kh21N6M2T as delivered was studied in 92% sulfuric acid in contact with the air or deaerated nitrogen. Polarization and gravimetric measurements were performed on cylindrical electrodes. The corrosion potential of the steels studied was measured with a pH meter and continuously recorded. The values of passivation and transition potential at 80°C varied

little with the speed of rotation of the cylindrical electrodes, whereas anodic dissolution rate increases significantly as rotating speed is increased to 5,000 rpm at potentials 0.025-0.050 V more negative than the critical potential, due to the facilitated transport of corrosion products under these conditions. Preliminary anodic passivation in 92% sulfuric acid at 80°C at +0.75 V for 5 to 60 minutes does not change the course of corrosion potential with time. The instability of corrosion potential of steels under the experimental conditions places certain limitations on the area of protection potentials selected. References 9: 7 Russian, 2 Western.  
[14-6508]

UDC: 620.193.2

#### MATHEMATICAL MODEL AND COMPUTATION OF PROBABLE RATE OF ATMOSPHERIC CORROSION OF METALS IN TROPICAL AND TEMPERATE CLIMATES

Moscow ZASHCHITA METALLOV in Russian Vol 21, No 4, Jul-Aug 85  
(manuscript received 19 Apr 84) pp 525-534

STREKALOV, P. V. and Vu DINVUY, USSR Academy of Sciences, Institute of Physical Chemistry; National Center of Scientific Research, Socialist Republic of Vietnam, Institute of Tropical Technology, Hanoi

[Abstract] A study is made of a simplified mathematical model of atmospheric corrosion of metals, describing the multiannual kinetics of corrosion considering the protective and shielding effect of the corrosion products, as well as meteorological and aerochemical factors. The model suggested is suitable for prediction of the corrosion of metals under the moist tropical conditions of Vietnam, as well as other climatic zones. References 20: 6 Russian, 14 Western.  
[14-6508]

UDC: 620.193.01

#### ELECTROCHEMICAL PROPERTIES OF Ti-Ni ALLOYS SYNTHESIZED IN TITANIUM BY IONIC IMPLANTATION OF NICKEL

Moscow ZASHCHITA METALLOV in Russian Vol 21, No 4, Jul-Aug 85  
(manuscript received 26 Jun 84) pp 544-547

TOMASHOV, N. D., KOVNERISTYY, Yu. K., CHERNOVA, G. P., KRASNOPEVTSEV, V. V., VAVILOVA, V. V., ZHILTSOVA, O. A., DRAVIN, V. A. and KHRUSHCHOV, M. M., USSR Academy of Sciences, Institute of Physical Chemistry

[Abstract] An attempt is made to create a surface titanium-nickel alloy which is close in composition to the intermetallide  $Ti_2Ni$  by implantation of

nickel ions in titanium on a flat titanium substrate. It was assumed that the surface thus modified could be used for the conduct of anodic reactions of release of chlorine and oxygen as is the case for monolithic crystalline  $Ti_2Ni$ . It was found that anodic polarization causes the formation of a mixed oxide on the surface similar to that formed on  $Ti_2Ni$ , with elevated electron conductivity and anodic currents for release of  $O_2$  and  $Cl_2$ . Nickel was implanted using a heavy ion accelerator manufactured by High Voltage Engineering Europe with a metallic nickel ion source, nickel ion current density 2.0-4.0 microamperes per square centimeter. The mixed oxide formed on the surface passivates the surface of the specimen, preventing dissolution of the components of the alloy. References 10: 5 Russian, 5 Western.  
[14-6508]

UDC: 620.193.4

HYDROGEN SULFIDE CORROSION OF STEELS AND ALLOYS FOR ELASTIC MEASUREMENT INSTRUMENT ELEMENTS

Moscow ZASHCHITA METALLOV in Russian Vol 21, No 4, Jul-Aug 85  
(manuscript received 19 Apr 84) pp 548-552

GUTMAN, E. M., MIKHEYCHIK, A. P., ANTONOV, V. G., GARNIK, Yu. M. and ZHDANOVA, A. S., All-Union Scientific Research Institute of Natural Gases

[Abstract] A study is made of a number of promising Fe-Ni-and Cr-based alloys containing molybdenum as well as high nickel alloys with elevated content of chromium plus molybdenum, copper and cobalt for the manufacture of elastic sensing elements for measurement devices for use in hydrogen sulfide-containing natural gas deposits. The passivation capacity of the materials is determined by their chromium content. Specimens were tested in vapor and liquid phases of a deaerated aqueous solution of 5% NaCl + 0.5%  $CH_3COOH$  with a partial hydrogen sulfide pressure 0.2-1.8 MPa and temperature of 20-150°C. The overall corrosion rate in the solution and its vapors increases in the sequence 36KhTYuM8, 06KhN28MDT, 36KhTYuM5, 40NKKhTYuMD, 68NKhVKTYu, 36NKhTYu, and is not over 0.03 mm/yr in the pressure range of 0.2-1.8 MPa and temperature range of 20-150°C.

References 13: 11 Russian, 2 Western.

[14-6508]

UDC: 541.138

SELECTIVE DISSOLUTION OF BINARY EUTECTIC ALLOYS. Zn-Cd AND Zn-Pb ALLOYS

Moscow ZASHCHITA METALLOV in Russian Vol 21, No 4, Jul-Aug 85  
(manuscript received 19 Jan 84; after revision 18 Jul 84) pp 566-571

SUKHAREV, N. P., ZHDANOV, V. V. and RAVDEL, A. A., Northwestern Polytechnical Correspondence Institute

[Abstract] A theoretical study is presented of the process of selective dissolution of the electronegative component from a binary eutectic alloy consisting of components which are mutually insoluble in the solid state. The specifics of eutectic structure formation allow the electronegative component to model a surface layer of an alloy as a porous matrix consisting of positive components. Time versus current diagrams were measured for Zn-Cd and Zn-Pd alloys during selective dissolution of the electronegative component--zinc. In zinc-hypereutectic alloys the variation of current density as a function of time weakens with an increase in zinc content in the alloy. The results can be explained by considering differences in the structure of the eutectic and hypereutectic alloys, which include relatively large primary zinc crystals. Given the large diameter of pores formed at the location of the primary crystals, mass transfer is supported by convective diffusion. The relatively weak variation of  $i$  as a function of  $t$  in hyper-eutectic alloys results from the fact that in addition to time-variable components, the selective dissolution current includes a constant component resulting from dissolution of the primary zinc crystals. References 17: 15 Russian, 2 Western.

[14-6508]

UDC: 620.193.01

INFLUENCE OF pH ON HYDROGEN CRACKING OF STEEL WITH CATHODIC POLARIZATION

Moscow ZASHCHITA METALLOV in Russian Vol 21, No 4, Jul-Aug 85  
(manuscript received 23 Apr 84) pp 577-579

IVANOV, S. S., TVERDYNIN, N. M., MOROZOVA, I. M. and AZHOGIN, F. F.,  
Moscow Evening Metallurgical Institute

[Abstract] A study is made of the influence of solution pH and current density on hydrogen cracking of high-strength type 40Kh2GSNMFA martensitic steel. Specimens of the steel were heat-treated by hardening from 930°C in air with subsequent tempering at 220-230°C, then ground to 100 x 8 x 2 mm. A bending stress of 1400 MPa was applied to degreased specimens with cathodic polarization. The time to cracking of the stressed specimens was determined in a 3% NaCl solution with pH 1.2, 4.2, 7.8 or 10.0, regulated by the addition of hydrochloric acid and sodium hydroxide. Electronographic analysis showed that, following cathodic polarization, the surface of the steel was

covered primarily with the oxides  $FeO$  and  $Fe_3O_4$ , the latter not being present before cathodic polarization. The cathodic polarization curves in the  $NaCl$  solution at pH 4.2 show that in the presence of reducing agents the  $Fe_3O_4$  film is formed at higher current densities than when they are not present. The data thus indicate the decisive role of chemical dissolution of iron and dissolved oxygen in hydrogen cracking of high-strength steel.

References 12: 11 Russian, 1 Western.

[14-6508]

UDC: 620.196

#### INTERCRYSTALLINE CORROSION OF STRESSED COPPER

Moscow ZASHCHITA METALLOV in Russian Vol 21, No 4, Jul-Aug 85  
(manuscript received 10 Apr 84; after revision 20 Aug 84) pp 586-588

KUZYUKOV, A. N., KHANZADEYEV, I. V. and KUZYUKOVA, A. N., Scientific Research Institute of Chemical Machine Building, Severodonetsk Branch

[Abstract] A study was performed to determine the influence of the stress state of copper on the rate of intercrystalline corrosion. Disk-shaped specimens of MZR copper were subjected to biaxial stress. The surfaces were mechanically worked to a roughness of 1.25. Some specimens were heat-treated for 8 hours at 573 K after welding, others were heat-treated before welding, still others were not heat-treated at all. The disks not heat-treated after welding had residual stresses in the area adjacent to the circular seam. Specimens were tested in 20%  $H_2SO_4$  plus 5% HF at 373 K. Analysis of solutions after testing revealed an increase in the content of copper and iron in the solution. HF facilitated dissolution of the solid solution of copper enriched in iron along the grain boundaries. The depth of corrosion was half or less as great in specimens heat-treated after welding, thus relieving internal stresses. Tensile stress facilitates intercrystalline corrosion in MZR alloy, which is prone to this corrosion because of the accumulation of iron at the grain boundaries. Reducing the iron content from 0.05 to 0.005% increases the resistance to intercrystalline corrosion.

References 6: all Russian.

[14-6508]

UDC: 620.197.3

STUDY OF CORROSION-MECHANICAL WEAR OF VTZ-1 TITANIUM ALLOY

Moscow ZASHCHITA METALLOV in Russian Vol 21, No 4, Jul-Aug 85  
(manuscript received 25 Jun 84) pp 588-591

TOLSTAYA, M. A., DMITRIYEV, V. A., KHOROSTUKHIN, L. A., SHILOVSKAYA, M. Ye.  
and KROPACHEV, V. S., Moscow Institute of Aviation Technology

[Abstract] Results are presented from studies of the electrochemical behavior of VTZ-1 titanium alloy in the process of friction. Media used included a 4.5% solution of "Ukrinol-1" lubricant-coolant and a hydraulic fluid based on an aqueous solution of polyethyleneglycol, and ethyleneglycol with oxyethylcellulose added. Aqueous solutions of sodium chloride, sulfate and nitrate were also used for comparison purposes. Polarization curves were measured for all friction couples, with the friction surfaces initially covered with paraffin. The potential curves indicate that the alloy is significantly self-passivated in friction in the lubricant-coolant fluid solution, but remains active in the hydraulic fluid. The significant corrosion-mechanical wear of VTZ-1 alloy in couple with VK6 alloy in contact with lubricant-coolant fluid and an aqueous-organic hydraulic fluid is determined practically entirely by the friction component. VTZ-1 is passivated in these media during friction, but due to the low value of the corrosion component in the corrosion-mechanical wear, anodic protection is practically useless. The depassivating influence of bromine ions decreases in the presence of friction, apparently due to the predominant adsorption of oxygen on the newly uncovered surface area of the specimen. References 9: 8 Russian, 1 Western.

[14-6508]

UDC: 620.193.4

CORROSION RESISTANCE OF PHOTANOODES OF TITANIUM DIOXIDE PARTIALLY REDUCED  
AND ALLOYED WITH CERTAIN METALS

Moscow ZASHCHITA METALLOV in Russian Vol 21, No 4, Jul-Aug 85  
(manuscript received 16 Oct 84) pp 591-594

KUZNETSOVA, Ye. G., KOROLEV, V. P. and STOYANOVSKAYA, T. N., Scientific  
Research Physical-Chemical Institute imeni L. Ya. Karpov

[Abstract] Corrosion studies were performed in 1 in KOH at 20°C on photo-anodes of titanium dioxide partially reduced and alloyed with 1 at.% aluminum, manganese, nickel, cobalt and 0.5 at.% niobium. The anodes were made from powdered  $TiO_2$  by pressing into tablets and sintering in an atmosphere of helium at 1200°C. The electrodes were polarized for 8 to 10 hours each day with simultaneous exposure to ultraviolet light, and then

polarization and illumination were turned off, though the electrode remained immersed in the solution. Test potentials varied from 0 to -0.15 V and in a few experiments 0.5 V. The conditions approximated those of photoelectrochemical solar energy converters, but with more intensive light. The tests established that the additives did not reduce corrosion resistance.

References 5: 2 Russian, 3 Western.

[14-6508]

UDC: 620.193.01

#### STRUCTURAL-PHASE SENSITIVITY OF ALUMINUM ALLOY REPASSIVATION POTENTIAL

Moscow ZASHCHITA METALLOV in Russian Vol 21, No 4, Jul-Aug 85  
(manuscript received 8 Aug 83; after revision 31 Oct 83) pp 598-601

BAKULIN, A. V. and PIVEN, I. S.

[Abstract] A study is presented of the variation in repassivation potential as a function of structure-phase composition of dispersion-hardened alloy type V92, an Al-Zn-Mg alloy with various hardening phases. Sheet specimens hardened from 450°C in water and naturally aged for 3 days were subjected to artificial aging at 90, 100, 110, 120, 140, 160, 180 and 200°C for 100 hours. Materials naturally aged for 2 years were also tested. Electrochemical studies showed that, with increasing artificial aging temperature, the pitting formation and repassivation potentials increase smoothly, causing the hysteresis loops to have the usual form right up to an aging temperature of 140°C. After aging at 160-200°C, there is a projection on the loop, indicating slowing of the repassivation process. The data indicate a higher structural-phase sensitivity of the repassivation potential of aluminum alloys than the pitting formation potential. References 6: 3 Russian, 3 Western.

[14-6508]

UDC: 669.15.018.8:621.039.5

#### INFLUENCE OF NICKEL INHIBITION ON RESISTANCE OF STAINLESS STEEL TO LIQUID LITHIUM

Moscow ZASHCHITA METALLOV in Russian Vol 21, No 4, Jul-Aug 85  
(manuscript received 20 Apr 84) pp 609-612

LYUBLINSKIY, I. Ye. and BESKOROVAYNYY, N. M.

[Abstract] The equilibrium solubility of nickel from a number of chrome and chrome-nickel steels in lithium containing not over  $1 \cdot 10^{-3}\%$  nonmetallic and 0.1% metallic impurities was determined over a broad temperature range by the method of absorption x-ray spectral analysis, which has a sensitivity for nickel

of  $1 \cdot 10^{-3}\%$  with excellent reproducibility and reliability of results. The maximum resistance to liquid alkali metals is observed in steels with limited content of chromium and other ferrite-stabilizing elements and the minimum content of nickel which assures stability of the austenite over the usage temperature range. References 15: 8 Russian, 7 Western.  
[14-6508]

UDC: 620.195

#### INFLUENCE OF VIBROGRINDING ON CORROSION RESISTANCE OF THE ALLOY ML-5 p.ch.

Moscow ZASHCHITA METALLOV in Russian Vol 21, No 4, Jul-Aug 85  
(manuscript received 12 Mar 84) pp 614-616

KHILCHEVSKIY, V. V., FEDORIN, A. M., GERASIMENKO, M. A. and GARBUZ, V. M.,  
Kiev Polytechnical Institute

[Abstract] A study is made of the influence of vibration grinding on the corrosion resistance of ML-5 p.ch. alloy. Cylindrical specimens were vibration ground after fine turning in abrasive granules measuring 5 to 20 mm on a type VM-100 vibration machine. The method of polarization resistance was used to determine the corrosion resistance of the magnesium alloys, the polarization resistance of specimens of the alloy being measured after mechanical working, vibration grinding and chemical processing in a 3% solution of sodium chloride at 20°C. The process of vibration grinding is found not only not to reduce corrosion resistance of the alloy, but in most cases actually to increase it significantly. References 2: both Russian.  
[14-6508]

UDC: 620.193.85

#### INFLUENCE OF MICROSCOPIC OVERGROWTH ON CORROSION OF METALS IN THE SEA

Moscow ZASHCHITA METALLOV in Russian Vol 21, No 4, Jul-Aug 85  
(manuscript received 16 May 84; after revision 12 Jul 84) pp 617-620

BUZOVKINA, T. B., ALEKSANDROV, V. A., SHLYAGA, L. I. and  
PEREKHVALSKAYA, N. D.

[Abstract] A comparison is presented of the influence of natural marine fouling organism communities in various stages of corrosion of structural alloys. Natural flora and fauna systems and seawater from the northwestern Black Sea were used in the study. Using the known sequence of formation of a fouling cenosis, model test media were selected to imitate conditions of biocorrosion in two main stages in the laboratory: the initial stage, several days in length with formation of the primary fouling film, and subsequent stage, several months in length, when the metal is in contact with

the inner layer of the overgrowth and where oxygen content is low. The change in potentials and rates of general corrosion of certain structural materials were determined under these conditions. Polarization curves were plotted under potentiostatic conditions at 2 minutes per point. The combination of aerobic organisms and organic matter in a continuous fouling film hindered diffusion of oxygen to the surface of the metal, creating anaerobic conditions at the metal surface. Sulfate-reducing bacteria accelerate marine corrosion, depolarizing the cathodic sectors and facilitating the formation of Fe-FeS galvanic couples. Corrosion of structural steels is slowed by the aerobic bacteria complex and increased by anaerobic bacteria in comparison to natural seawater. References 10: 6 Russian, 4 Western.  
[14-6508]

UDC: 620.193

CHANGE IN CORROSION RATE OF STEEL TYPE 10 WITH TIME IN INHIBITED CARBON SLURRY

Moscow ZASHCHITA METALLOV in Russian Vol 21, No 4, Jul-Aug 85  
(manuscript received 19 Mar 84) pp 626-628

PODOBAYEV, N. I. and MARTYNOVA, T. V., Moscow State Pedagogic Institute imeni V. I. Lenin

[Abstract] It is important to establish the way the corrosion rate changes over the length of a coal slurry pipeline in order to determine the effectiveness of protection of the pipeline from corrosion by means of calcium hydroxide. Corrosion losses of a slurry line are calculated for corrosion with oxygen depolarization. Corrosion losses are found to be decreased by almost an order of magnitude. At pH 8, absorption of oxygen by the coal decreases corrosion by a factor of about 4.4, at pH 12.5 - by a factor of about 40. With an excess of alkali, the corrosion rate is seven to eight times lower, since the oxygen absorption rate by the coal is significantly higher than when 1.6 g/l of Ca(OH)<sub>2</sub> is present.

References 2: both Russian.  
[14-6508]

HYDROGEN EMBRITTLEMENT OF DEFORMABLE HIGH-CARBON STEEL AND EFFECTIVENESS OF INHIBITOR PROTECTION

Moscow ZASHCHITA METALLOV in Russian Vol 21, No 4, Jul-Aug 85  
(manuscript received 20 Mar 84) pp 628-631

SHEYN, A. B. and PETUKHOV, I. V., Perm State University imeni A. M. Gor'kiy

[Abstract] A study is made of the influence of elastic deformation on hydrogenation of high-carbon steel with cathodic polarization in a sulfate electrolyte containing inhibitors of various types. Wire specimens 0.25 mm in diameter and 120 mm long were used, made of high carbon type U9A steel, 0.89% C, annealed in a vacuum of  $1 \cdot 10^{-3}$  Pa at 850°C for 2 hours. Specimens were elastically deformed by uniaxial extension at 20 to 60% of tensile strength and saturated with hydrogen in 1 n H<sub>2</sub>SO<sub>4</sub> ( $i_C = 4 \cdot 10^2$  A·m<sup>-2</sup>, time 1 hour) containing hydrogenation stimulator As<sub>2</sub>O<sub>3</sub> and the inhibitors PGU-1, cetylpyridinium chloride (CPC) and tetraethylammonium iodide. The specimens were then tensile-tested, and stress-strain diagrams were used to determine the change in strength and ductility characteristics. Inhibitor PGU-1 was found to be the most effective inhibitor tested. This does not agree with polarization measurements, which indicated CPC to be the most effective, indicating that electrochemical measurements alone cannot be relied upon. Protection of steels with inhibitors must be performed considering the decrease in the effectiveness of these inhibitors under stress corrosion conditions. References 10: 5 Russian, 5 Western.

[14-6508]

/9835

UDC 621.318.132:539.216:538.569.4

EFFECT OF PLANE ANISOTROPY OF ELECTRICAL RESISTIVITY ON FERROMAGNETIC RESONANCE IN THIN MAGNETIC FILMS

Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 60, No 2, Aug 85 (manuscript received 10 Aug 84) pp 275-278

KORNEV, Yu. V., SEMENTSOV, D. I., SIDORENKO, V. V. and SEMENTSOVA, T. M., Moscow Higher Technical School imeni N. E. Bauman

[Abstract] A relation is established between plane anisotropy of electrical resistivity in thin films of ferromagnetic materials such as Permalloy on anisotropic substrate materials such as mica or polyethylene terephthalate and ferromagnetic resonance in these films. Taken into account are the presence of preferentially oriented defects in the form of microcracks in planes of the film as well as the existence of a skin layer of much lower microwave field intensity. The latter distorts the otherwise uniform distribution of the high-frequency magnetization component and thus cases a shift of the resonance frequency with an attendant widening of the resonance line. Calculations based on the equation of propagation for the magnetic moment, involving the gyromagnetic effect and intrinsic relaxation, yield the resonance magnetic field intensity  $H_r$  and the width of the resonance line  $\Delta H$  as functions of the angle  $\theta$  in planes of the film. Experimental data on that  $H_r(\theta)$  pattern confirm that the amplitude of oscillations  $\Delta H(\theta)$  is much larger in a film with anisotropy of electrical resistivity (conductivity) than in films with only magnetic but no electric anisotropy. Conversely, therefore, the anisotropy of electrical resistivity in films in external magnetic fields stronger than the magnetic anisotropy field can be determined from  $H_r(\theta)$  and  $\Delta H(\theta)$  measurements. References 5: all Russian. [32-2415]

INFLUENCE OF NICKEL ON FRACTURE RESISTANCE OF LOW-CARBON STEELS

Moscow METALLOVEDENIYE I OBRABOTKA METALLOV in Russian No 9, Sep 85, pp 22-27

DEMYGIN, N. Ye., GORITSKIY, V. M., KHROMOV, D. P., GUSEVA, I. A. and VESOLAYNEN, O. Ya.

[Abstract] Results are presented from studies of the influence of nickel on the structure, resistance to brittle fracture and fractographic characteristics of fracture of low-carbon steels types ON3, ON6 and ON9. Plates of the three steels measuring 100 x 140 x 12 mm were austenitized at 850, 800 and 780°C for ON3, ON6 and ON9, respectively; one portion of the plates was then cooled in water, another in air. Tempering was performed at 300-700°C for 2.5 to 3.0 hours with subsequent cooling in air. Smooth cylindrical specimens 6 mm in diameter were used for tensile testing; transverse prismatic specimens were used for impact bend testing. Electron microscope studies of foils and carbon replicas were performed. Increasing the content of nickel from 3.4 to 9.1% was found to increase the tendency of the low-carbon steels tested to the formation of rack martensite and to increase the volumetric fraction of residual primary austenite. After cooling in water, ON3 has a ferrite-martensite structure, while ON6 and ON9 have martensite structure. After cooling in air a ferrite structure is formed in ON3 and ON6 steels, in ON9 - ferrite-martensite. Increasing the content of nickel from 3.4 to 9.1% causes an increase in pit size after brittle fracture, particularly in the steel cooled in air. After cooling from the austenite area, residual austenite is observed in the steels along the boundaries of the martensite racks and as individual islands within alpha-ferrite grains, while after tempering it is present as circular segregations along the boundaries and within the grains of alpha ferrite. Tempering forms stable secondary austenite, increasing cold shortness and specific crack propagation work. References 6: 3 Russian, 2 Western, 1 East European.

[19-6508]

UDC: 620.196.5:669.15'74-194

## INFLUENCE OF NONMETALLIC INCLUSIONS ON FRACTURE OF 20GFL STEEL

Moscow METALLOVEDENIYE I OBRABOTKA METALLOV in Russian No 9, Sep 85, pp 27-30

AKSELROD, A. Ye., ZHITOVA, L. P., KNYAZEVA, V. I. and SARRAK, V. I., Urals Scientific Research Institute of Ferrous Metallurgy; Central Scientific Research Institute of Ferrous Metallurgy imeni I. P. Bardin

[Abstract] A study is presented of the influence of the quantity and morphology of nonmetallic inclusions on the fracture resistance characteristics of type 20GFL steel. The internal fracture surfaces along which fracture of cast steels occurs are also determined. The properties of steels of the same type from several melts were studied. Metallographic studies were performed on unetched sections. The quantity and morphology of sulfides and oxides in the steel were determined. It was found that needle-shaped nonmetallic inclusions in unmodified 20GFL steel weaken the boundaries of the primary austenite grains and serve as centers of formation of cracks. Globularization and reduction of the size of nonmetallic inclusions, decreasing their quantity and increasing dispersion of their dendritic structure in the steel, which has been deoxidized by the use of silicocalcium or produced using metallized pellets, all help to increase the strength of the primary austenite grain boundaries. Formation of cracks on such boundaries is hindered, increasing the impact toughness of the steel. References 6: all Russian.

[19-6508]

UDC: 669.14.018.8:620.191.4

## INFLUENCE OF COOLING RATE AND HEAT TREATMENT ON CHEMICAL MICROHETEROGENEITY OF TYPE 09Kh16N4BL STEEL

Moscow METALLOVEDENIYE I OBRABOTKA METALLOV in Russian No 9, Sep 85, pp 35-37

ANASTASIADI, G. P., KOLCHINA, R. V. and SMIRNOVA, L. N.

[Abstract] In order to determine the content of chromium and nickel in the delta-ferrite and martensite, bars of type 09Kh16N4BL steel were sand-cast, and the contents of the elements in the structural components were determined in the cast state after heating the specimens to 1200 and 1300°C and cooling them in water, or heating to 1300 and 1350°C with cooling in the vacuum furnace, after holding them for 1 hour in all cases. The results show that the stability of the delta ferrite segregated along the boundaries of dendrites is determined by the liquation of chromium above the mean chemical composition in the process of crystallization. During subsequent cooling in the region of the delta to gamma conversion, the difference in

chemical composition of stable delta ferrite located along the dendrite grain boundaries and austenite increases, leading to enrichment of the delta ferrite with chromium and impoverishment with nickel, still further increasing its stability. The content of these elements is determined by the rate of cooling during subsequent delta to gamma transformation in the 1100-1400°C temperature range. References 4: 2 Russian, 2 Western.

[19-6508]

UDC: 620.178.2:699.15'26-194

#### INFLUENCE OF CHEMICAL MICROHETEROGENEITY OF SOLID SOLUTIONS ON BRITTLENESS OF CHROME STEELS

Moscow METALLOVEDENIYE I OBRABOTKA METALLOV in Russian No 9, Sep 85,  
pp 38-42

MADYANOV, S. A., SEDOV, V. K. and APAYEV, B. A., Gorkiy Physical-Technical Research Institute

[Abstract] When the tempering temperature of chrome steels is increased to over 910°C, it is thought that changes in the electron structure of the iron might create conditions for redistribution of chromium atoms and development of high-temperature chemical heterogeneity of the solid solution. This assumption was tested using single-phase steels type Kh15 and Kh20 with an alpha solid solution structure. Specimens were heated to 1250°C, held at that temperature 1 hour, then cooled to 1050, 800 or 600°C, with subsequent isothermal holding 3 hours and cooling in water to eliminate the influence of structural factors and isolate the significance of the interatomic interaction in the formation of solid solution heterogeneity. Chemical microheterogeneity was determined with an x-ray spectral microanalyzer. The existence of the high-temperature region of chemical heterogeneity was confirmed. This heterogeneity makes a contribution to the development of various types of chrome steel brittleness. All types of chrome steel brittleness are identically manifested as a change in the capacity for microplastic deformation and can be used for nondestructive testing of embrittlement processes. References 7: all Russian.

[19-6508]

FORMATION OF STRUCTURE DURING RECRYSTALLIZATION OF COLD-ROLLED 06Kh18ch  
SHEET STEEL

Moscow METALLOVEDENIYE I OBRABOTKA METALLOV in Russian No 9, Sep 85, pp 42-43

BABITSKAYA, A. N., MISHCHENKO, V. G. and MOVSHOVICH, V. S., Zaporozhye  
Machine Building Institute imeni V. Ya. Chubar; Zaporozhye Zaporozhstal  
Metallurgical Combine imeni S. Ordzhonikidze

[Abstract] The purpose of this work was to determine the optimal conditions of recrystallization of heat-treated cold-rolled 06Kh18ch steel for the production of equilibrium structure. Studies were performed on commercially-made steel containing 0.06% C, 0.02% Mn, 0.20% Si, 0.035% P, 0.09% S, 18.45% Cr, 0.41% Ni, 0.15% Cu, 0.05% V, 0.12% W. To the steel were added 0.38% ferrocerium type FTSM5, 0.2% Ca and 0.005% Mg. Specimens were cut from 0.76 mm strips, heated to 850-1200°C and held for 1, 2, 3, 4, 5 and 30 minutes, and then cooled in water, to imitate the conditions of hardening in the manufacturing plant. The studies established that the temperature at the end of hot rolling, 850-950°C, does not support recrystallization of the structure. After holding at these temperatures, the structure of the steel is heterogeneous, with alternating light and dark components. The hardness of the steel after hot working is HRB87. When cold-rolled strips are heated to 850-950°C, recrystallization of the ferrite grain does occur and the martensite sectors decompose into a ferrite-carbide mixture. Heating to over 950°C causes dissolution of the carbide phase and saturation of the solid solution with carbon, while subsequent rapid cooling forms martensite in the structure of the steel. Microhardness is somewhat decreased after heating to 900-950°C. Beginning at 1000°C, intensive increases in microhardness of cold rolled steel are observed as a result of dissolution of carbides and formation of martensite. Heating to 920-950°C, heating time 2 minutes per mm thickness, with subsequent rapid cooling this supports the production of the maximum ductility of cold-rolled type 06Kh18ch steel.

References 2: both Russian.

[19-6508]

UDC: 669.24:620.192.47:621.785.3

STRUCTURE AND PROPERTIES OF KhN62BMKTYu ALLOY UPON HIGH-TEMPERATURE HEATING

Moscow METALLOVEDENIYE I OBRABOTKA METALLOV in Russian No 9, Sep 85,  
pp 44-47

MASLENKOVA, Ye. A., ABRAMOV, O. V. and MASLENKOV, S. B., Institute of Solid State Physics, USSR Academy of Sciences; Institute of Metallurgy imeni A. A. Baykov

[Abstract] An attempt is made to estimate the deformability of KhN62BMKTYu steel based on ductility characteristics in dynamic tensile tests. The influence of temperature in the 100-1200°C interval on microstructure and mechanical properties of KhN62BMKTYu heat-resistant alloy was studied. The chemical composition of the alloy tested was 0.05% C, 14% Cr, 10% Co, 4.9% Mo, 2.6% Nb, 2.7% Ti and 2.7% Al, with a high content of the hardening phase, deformed by extension at 5 m/min. As the test temperature increased, the strength properties decreased while ductility increased, reaching its maximum at 1100°C, then rapidly decreasing. Impact toughness also decreases above 1100°C. Processes of dynamic recrystallization occurred during high-speed tensile testing at 1050°C or above, with secondary dynamic recrystallization occurring at 1100°C or above. Grain size differences observed between 1100 and 1130°C lead to a slight decrease in plasticity. High-temperature decreases in ductility may result from an increase in the concentration of pores at large grain boundaries. Very fine grain and increased ductility at the recrystallization temperature make it possible to improve the technology of working the alloy. References 11: 9 Russian, 2 Western. [19-6508]

UDC: 621.78:669.14.018.44

INFLUENCE OF HEAT TREATMENT ON FRACTURE OF 55Kh20G9AN4 VALVE STEEL

Moscow METALLOVEDENIYE I OBRABOTKA METALLOV in Russian No 9, Sep 85,  
pp 47-49

VERNER, K. A., ZELENOVA, V. D., MIKHEYEVA, V. V. and KNOROZOVA, T. B.

[Abstract] Type 55Kh20G9AN4 steel is used for the manufacture of motor vehicle exhaust valves. The steel is hardened from 1180-1190°C and aged 760-780°C for 13 to 16 hours. The long-term strength is somewhat reduced by this treatment, but reliable operation of motors over a long period of time is supported. However, reported failures consisting of fractures in "cold" locations on the valve stem stimulated studies of the influence of heat treatment on impact toughness and the nature of valve fracture. Impact bending testing at normal temperatures was performed on cylindrical specimens 8 mm in diameter with and without notches. The specimens were cut

from actual valve stems. The surfaces of fractures were studied on a scanning electron microscope. The influence of aging on microstructure, work of fracture and fracture surface after preliminary hardening from 1120 and 1190°C was studied with two aging modes: at 760 and at 880°C for 13-16 hours.

Aging at 760°C decreases the work of fracture, regardless of hardening temperature to 880°C leads to an increase in the segregation of the "gray phase," coagulation and partial dissolution of secondary finely dispersed carbides in the solid solution, increasing the work of fracture of unnotched specimens slightly. Hardening from 1120°C with subsequent aging at either temperature, as well as annealing at 880°C, results in viscous fractures. Hardening from 1190°C with subsequent aging at either temperature results in brittle fractures. Low-temperature hardening with subsequent aging or annealing must be used for valves which will be exposed to impact loading.

References 2: 1 Russian, 1 Western.

[19-6508]

UDC 669.18.004.18

#### RESERVES FOR METAL ECONOMY

Dnepropetrovsk METALLURGICHESKAYA I GORNORUDNAYA PROMYSHLENNOST in Russian  
No 2, Apr-Jun 85 pp 13-15

BELOPOLSKIY, G. M., OLEKSENKO, V. V. and PANIOTOV, Yu. S., Dnepropetrovsk  
Institute of Metallurgy

[Abstract] Several measures have been introduced in large steel-making enterprises which will reduce the reject rate and thus improve metal economy. The main causes for rejection of ingots are fissures and blisters. These can be minimized by regulating the ladle temperature and not allowing it to rise excessively and by increasing the carbon content as well as adding manganese. These measures have yielded satisfactory results in the Zaporozhye Steel Combine producing 3SP and 20PS-boiler steel as well as in the Krivorog Steel Combine producing 2KP-strip steel.

[20-2415]

PRODUCTION AND QUALITY OF STEEL FOR RAILROAD WHEELS

Dnepropetrovsk METALLURGICHESKAYA I GORNORUDNAYA PROMYSHLENNOST in Russian  
No 2, Apr-Jun 85 pp 15-16

SHNEYEROV, Ya. A., LAVRENKO, S. I., SHAPOVALOV, V. I., ANDREYEV, B. K.,  
PROYDAK, Yu. S. and KUSHNIR, Yu. B., Institute of Ferrous Metallurgy, USSR  
Ministry of Ferrous Metallurgy; Dnepropetrovsk Institute of Metallurgy;  
Nizhnednepetrovsk Pipe Rolling Plant

[Abstract] The quality of steel produced at the K. Liebknecht plant and other plants for railroad wheels needs to be improved so as to match the increasing weight and speed of the rolling stock. The high carbon content and the detrimental side effect of using aluminum directly and alone make it necessary to seek other means of killing the steel and of preventing cold shortness. A study was made at the Cherepovets Metallurgical Combine to evaluate the following methods: 1) using silicocalcium (1 kg/t) in a two-slag process; 2) using silicocalcium (1 kg/t) in a one-slag process; 3) using silicocalcium (1 kg/t) in a one-slag process with subsequent vacuum refining; 4) using aluminum (0.3 kg/t) in a one-slag process; 5) using aluminum (0.3 kg/t) after vacuum refining. The last method yielded steel of the best quality for the particular application when produced in an electric furnace. Blow-through of steel in the ladle was also found to be preferably done by passing the inert gas (argon) through porous plugs in the bottom rather than through a submersible tuyere.

[20-2415]

KINETICS OF SOLIDIFICATION OF STRUCTURAL-GRADE 40Kh STEEL IN CONTINUOUSLY CAST INGOT

Dnepropetrovsk METALLURGICHESKAYA I GORNORUDNAYA PROMYSHLENNOST in Russian  
No 2, Apr-Jun 85 pp 16-18

DYUDIN, D. A., ONOPCHENKO, V. M., KONDRATYUK, Yu. M., KONDRATYUK, A. M.,  
PAUKOV, A. V. and SIRCHENKO, V. I., Donetsk Scientific Research Institute  
of Ferrous Metallurgy

[Abstract] To study its solidification kinetics, 40Kh steel was cast in a vertical continuous-casting machine into ingots 250x500 mm<sup>2</sup> and 200x400 mm<sup>2</sup> in cross-section. Both sizes were cast from a ladle at 1650°C, the temperature of the larger ingots dropping to 1560-1575°C and the temperature of the smaller ingots dropping to 1525-1535°C as steel was poured with submersible graphite-corundum cups into crystallizers. The free surface of liquid metal in the crystallizer was protected with amorphous graphite, cooling water was supplied at the rates of 180 m<sup>3</sup>/h and 165 m<sup>3</sup>/h

respectively. The bottom of the liquid column and the solidification front were monitored by beads of radioactive isotope, total activity 0.4 GBk, immersed on rods into molten lead poured together with the steel into the crystallizers. The upper crusts of the ingots were sliced for radiographic examination. The results indicate that the solidification kinetics of this steel can be described by the power-law relation  $\delta = K_T^n$  between depth  $\delta$  of the solid layer and time  $\tau$ , with the exponent  $n = 1/2$  and the coefficient  $K$  depending on the ingot size. Smaller ingots solidify faster than larger ones, the  $200 \times 400 \text{ mm}^2$  size at  $11-12 \text{ mm/min}$  ( $K = 3.11-3.14 \text{ cm/min}^{0.5}$ ) and the  $250 \times 500 \text{ mm}^2$  size at  $9-10 \text{ mm/min}$  ( $K = 2.59-3.08 \text{ cm/min}^{0.5}$ ). Experiments were performed with the assistance of Yu. I. Povkh; data were processed statistically by S. L. Bychkovskiy and M. A. Vorobyeva. References 1: Russian.  
[20-2415]

UDC 621.771.294.002.237

#### DEVELOPMENT AND REFINEMENT OF TECHNOLOGY FOR PRODUCTION OF RAILROAD WHEELS

Dnepropetrovsk METALLURGICHESKAYA I GORNORUDNAYA PROMYSHLENNOST in Russian  
No 2, Apr-Jun 85 pp 26-28

YESAUNOV, A. T., STAROSELETSKIY, M. I., VALETOV, M. S., SHIFRIN, M. Yu.  
and KORZH, V. I., Nizhnednepetrovsk Pipe Rolling Plant  
imeni K. Liebknecht; Institute of Ferrous Metallurgy, USSR Ministry of  
Ferrous Metallurgy

[Abstract] The technology of producing railroad wheels at the K. Liebknecht plant has been refined so as to ensure minimum variance throughout the process, beginning from the quality of steel ingots up to the final dimensions. Attainment of this goal, along with a substantial boost in the production rate of acceptable wheels, is made possible by installation of modern furnaces and heat treatment facilities as well as highly mechanized forging and rolling operations. Stamping proceeds in three stages: first of the wheel blanks in a 100 MN press, then of rims and flanges in a 35 MN press, and of the hubs separately in a 5 MN press. Heat treatment is done on conveyor belts with speed control, wheels being precooled for subsequent heating from  $400-550^\circ$  to  $650^\circ\text{C}$  and holding at that temperature for 3-4 h. The wheels thus produced meet the applicable GOvernment STandard 9036-76 and rank among the best in the world. The technology was developed with the assistance of V. N. Stalnokritskiy, V. N. Krashevich, Yu. G. Tuboltsev, V. T. Belousov and A. P. Babushkin.  
[20-2415]

UDC 669.14.018.295:543]:669.18.046.516

EFFECT OF ALLOYING ON PHASE TRANSFORMATIONS, STRUCTURE AND PROPERTIES OF HIGH-STRENGTH LOW-CARBON STEELS

Dnepropetrovsk METALLURGICHESKAYA I GORNORUDNAYA PROMYSHLENNOST in Russian  
No 2, Apr-Jun 85 pp 33-35

YATSENKO, A. I., UZLOV, I. G. and DOKONKIN, K. Yu., Institute of Ferrous Metallurgy, USSR Ministry of Ferrous Metallurgy

[Abstract] Manganese is used as principal alloying element in special low-carbon steels for sheet stock which must combine high strength with adequate plasticity. The advantages of Mn are its ability to harden ferrite and to stabilize austenite, while lowering the transformation temperatures of the latter. However, it also lowers the plasticity of steel during hot or cold deformation and raises its sensitivity to fluctuations of the rolling temperature and to cooling with an attendant chemical and structural de-homogenization of the steel. Since manganese is also a scarce and expensive metal, a laboratory study was made to establish the feasibility of its partial or possibly complete replacement with more abundant alloying elements without sacrificing steel quality. With the carbon content in the 0.05-0.10% range, the total content of all other alloying elements was varied first over the 0.10-10% range and then over the narrow 2-2.5% range. Silicon was added for stabilization of the ferrite, and manganese was retained for stabilization of the austenite. In addition, minuscule amounts of deoxidizers (Al, Ca, Ba, Zr) were added for further optimization of the steel characteristics. Steel with only 0.2-0.5% Mn and with 0.3-1.0% Si or 0.7-2.5% Si was developed as a result, both grades being less expensive than the 08GSYuT steel but having comparable properties. For extra high strength and only somewhat lower plasticity, 1.3-1.7% Mn should be retained with 0.7-1.5% Si and with the carbon content raised to 0.19-0.26% C.

[20-2415]

UDC 621.774.353:621.184.8]:620.17/.18

MECHANICAL PROPERTIES AND MICROSTRUCTURE OF SINGLE-PASS AND DOUBLE-PASS TUBES OF 12Kh18N12T STEEL FOR STEAM SUPERHEATERS

Dnepropetrovsk METALLURGICHESKAYA I GORNORUDNAYA PROMYSHLENNOST in Russian  
No 2, Apr-Jun 85 pp 40-41

VILYAMS, O. S., KOVALEVA, A. D. and DASHKOVSKAYA, N. N., Nikopol Southern Pipe Manufacturing Plant

[Abstract] A laboratory study of pipes of 12Kh18N12T steel for steam superheaters was made, for the purpose of explaining the wide differences between the mechanical properties of such pipes produced by single-phase rolling and by double-pass rolling, respectively. Microstructural examination

and chemical analysis have revealed that, that while the chemical composition plays an important role, grains size and heating temperature are the principal factors responsible for those differences. Single-pass tubes with larger grains in the microstructure, more strain hardened during rolling and consequently more softened during heating, have therefore a lower strength than double-pass tubes. It does not appear to be feasible to narrow the 539-686 MPa range of ultimate strength as quality criterion down to a 100-120 MPa wide one.

[20-2415]

UDC 669.15'26'24-194:620.178.162:620.187.3

ELECTRON-DIFFRACTION ANALYSIS OF PHASE TRANSFORMATIONS AT FRICTION SURFACE OF 14Kh17N2 CHROMIUM-NICKEL STEEL

Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 60, No 2, Aug 85 (manuscript received 25 Apr 84, in final version 18 Jul 84)  
pp 313-319

LEBEDEVA, I. L. and POKHIL, Yu. A., Low Temperatures Physical Technical Institute, UkrSSR Academy of Sciences

[Abstract] Formation of secondary structures with attendant phase transformations occurring within thin surface layers of metals as a result of frictional interaction were studied in an experiment involving electron-diffraction analysis of contact surfaces in "indentor-disk" friction pairs. Both elements of these pairs were made of 14Kh17N2 chromium-nickel steel, a martensitic steel containing 0.11-0.17 wt.% C, 16-18 wt.% Cr, 1.5-2.5 wt.% Ni, < 0.8 wt.% Si and < 0.8 wt.% Mn. Rods of this steel had been quenched in oil from 1050°C and subsequently tempered at 640°C. This heat treatment had produced a martensitic structure with approximately 30 wt.% of a special stable carbide  $(\text{Cr},\text{Fe})_{23}\text{C}_6$  + δ-ferrite. Bars 70 mm in diameter were cut into 10 mm long disks, and from these bars cylindrical indentors 18 mm long with a 3.8 mm diameter were made. Their initial microhardness, prior to friction tests, corresponded to 3300 MPa. They were tested in friction under a specific load of 2.7 MPa in a vacuum of  $10^{-5}$  Pa. The electron-diffraction patterns recorded in thin foils of surface layers reveal that no austenite transformation occurs at rubbing velocities up to 0.3 m/s, that the  $A_{\text{c}1}$  temperature is reached and exceeded at rubbing velocities within the 0.3-0.8 m/s range, and that α-phase rings as well as  $\theta\text{-Fe}_3\text{C}$  carbide along with γ-phase rings begin to form at a rubbing velocity of 1.0 m/s. These results indicate that, depending on strain and temperature, carbon tends to segregate within the contact zone, this redistribution beginning even in the austenite phase before secondary martensite is formed. References 20: 17 Russian, 3 Western.

[32-2415]

STRUCTURE AND PROPERTIES OF STRUCTURAL STEELS DEFORMED IN MARTENSITE STATE BY HYDROEXTRUSION WITH COUNTERPRESSURE

Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 60, No 2, Aug 85  
(manuscript received 17 Sep 84, in final version 23 Nov 84) pp 344-350

DAVYDOVA, L. S., DEGTYAREV, M. V., LEVIT, V. I. and SMIRNOVA, N. A.,  
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[Abstract] A study of structural steels 37KhN3M and 30KhGSN2A was made, for the purpose of determining the dependence of their dislocation structure and fracture surface microstructure, mechanical properties and cold-shortness temperature after hydroextrusion on the original austenite structure, on the tempering temperature and time, on the degree of deformation and on the counterpressure during treatment. Specimens of 30KhGSN2A steel, rods 30 mm in diameter, had been quenched after hot rolling but so as to allow recrystallization into a fine-grain austenite. Specimens of 37KhN3M steel, rods 20 mm in diameter, had been tempered at 950 K for 2 h and then slowly cooled in a furnace. One lot of those 37KhN3M specimens, 200 mm long, was subsequently heated to 1130 K, held at that temperature for 30 min, rolled at a rate of 0.4 m/s to a 30% reduction in a single pass, and fast-cooled in oil so as to completely suppress recrystallization. Another lot of those 37KhN3M specimens, turned down to a 16 mm diameter, was also subjected to such a high-temperature thermomechanical treatment, but with quenching after 30 min without deformation. The remainder of those 37KhN3M specimens, also turned down to a 16 mm diameter, was quenched after being heated in a salt bath to 1130 K and held at that temperature for 3.5 min. All specimens were now tempered at 470 K for 1 h and then galvanized prior to hydroextrusion with counterpressure in a specially built device. Under a pressure up to 1 GPa, with up to 0.3 GPa counterpressure, 5-22% reduction was attained in one pass, and a total 46% reduction to a 11 mm diameter was attained in 3-4 passes. Most specimens were tempered at 470 K for 1 h after each pass, some at 570 K for testing their proneness to irreversible temper brittleness. This was followed by tension tests and "Mesnager" notched-bar impact tests as well as structural examination under a EPITYP optical microscope and a JEM-100C electron microscope, with a STEREOSCAN-100 instrument for scanning the fracture surface. The results of this study indicate that hydroextrusion with large reduction increases the tensile strength of both steels, quenched and low-temperature tempered, without appreciable loss of plasticity and toughness. Deformation by hydroextrusion, without changing the threshold temperature of cold shortness, lowers the proneness of these steels to irreversible temper brittleness. While the counterpressure during hydroextrusion does not directly influence the mechanical properties of these steels, it is absolutely needed for preventing fracture during hydroextrusion with larger than 30% reduction. The ingots of 37KhGSN2A steel were supplied by A. P. Bashchenko and Ya. B. Gurevich, and the special hydroextrusion device was designed and built under the guidance of B. I. Kamenetskiy. Density measurements by hydrostatic weighing were made by A. V. Shalimova.

References 17: 15 Russian, 2 Western.

[32-2415]

EDDY CURRENTS IN AMORPHOUS FERROMAGNETIC MATERIALS

Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 60, No 2, Aug 85  
(manuscript received 22 Aug 84) pp 412-415

MINAKOV, V. I. and FEDOSOV, V. N., "Voronezh Polytechnic Institute

[Abstract] Eddy-current power loss in amorphous soft ferromagnetic materials is evaluated on the basis of a magnetization distribution model for a ribbon of such a material, considering a domain structure with plane shape anisotropy produced by unannealable defectiveness and an ideally smooth transverse magnetization profile across that domain structure. Only exchange energy and Zeeman energy are included in the analysis. Demagnetization by the edge effect is taken into account, but reaction of eddy currents on the magnetization is disregarded, except for determining the frequency dependence of the magnetic permeability. The angle between the magnetization vector and the transverse axis is defined in variational terms with the domain width as the key parameter. The electric field intensity is calculated from its curl and divergence, assuming a solenoidal magnetization field, whereupon an expression is obtained for Joule-effect power. This expression simplifies greatly for the case of wide domains, analogous to microeddy-current power loss anomaly in crystalline materials. A simple expression is also obtained for the relaxation time at the low-frequency limit of magnetization reversal, proportional to the product of electrical conductivity and magnetic permeability. The latter is found to have a Debye frequency characteristic. Typical numerical values are given for metallic glasses. References 10: 2 Russian, 8 Western (1 in Russian translation).

[32-2415]

/9835

NON-FERROUS METALS AND ALLOYS: BRAZES AND SOLDERS

UDC: 669.26'3:620.186

KINETICS OF DECOMPOSITION OF SUPERSATURATED SOLID SOLUTIONS OF CHROMIUM BRONZES

Moscow METALLOVEDENIYE I OBRABOTKA METALLOV in Russian No 9, Sep 85, 50-53

FEDOROV, G. M., FEDOROV, V. N., KHAN, M. G. and MANUYLOV, A. T.

[Abstract] A study is presented of the influence of heating temperature before hardening on the stability and kinetics of decomposition of the solid solution of chrome bronze BrKh07. Studies were performed on bronze specimens containing 0.66% Cr produced in a vacuum induction furnace. The hardening temperature was varied between 870 and 1050°C. C curves, showing the degree of decomposition of the solid solution as a function of hardening temperature, showed two segments, with minimum stability of the supersaturated solid solution for hardening from 1050, 1010 and 920°C and one for hardening from 870°C. Increasing the heating temperature for hardening results in a significant decrease in stability and an increase in the rate of decomposition of the supersaturated solid solution at lower temperatures. At high aging temperatures, particles of the secondary phase are segregated along grain boundaries; at low temperature they are segregated throughout the entire volume of the grain. The content of chromium in the solid solution and grain size largely determine the stability of the solid solution at high temperatures, while at lower aging temperatures the concentration of hardening vacancies and chromium concentration in the solid solution are important. References 5: 2 Russian, 3 Western.

[19-6508]

UDC: 669.3'5:621.7.011

INFLUENCE OF GRAIN STRUCTURE AND STRESS CONCENTRATORS ON DEFORMABILITY OF L80 BRASS STRIPS

Moscow METALLOVEDENIYE I OBRABOTKA METALLOV in Russian No 9, Sep 85, pp 53-55

ZASTOLSYAYA, Z. K., VOLKOV, A. K. and IVANOV, G. P., Vladimir Polytechnical Institute

[Abstract] Results are presented from a study of the influence of grain size and stress concentrators on the mechanical properties of type L80 brass. Tensile specimens 180 x 20 x 0.13 mm were cut in the longitudinal direction from tubes to be used for the manufacture of bellows. A 1 x 1 mm grid was placed on the 100 mm gage section before testing. During testing, tensile strength, relative elongation and intensity of deformation both within the elongation zone and after fracture were determined. It was found that as the mean grain size increased from 8 to 11 micrometers, the short-term strength remained practically unchanged, but relative elongation decreased to 5-7% less than the permissible value for brass strip. Short-term strength and relative elongation for specimens with grain sizes of 26 and 65 micrometers are significantly below the requirements of the State Standards. Diamond pyramid indentations did not have any influence on the mechanical properties of the strip. Other stress concentrators did not influence short-term strength but significantly reduced relative elongation, by a factor of five for scratches made with a load of 15 N. Grain size and stress concentrators thus have more influence on elongation area than on short-term strength.

References 6: all Russian.

[19-6508]

UDC: 669.715:620.193

INCREASING CORROSION RESISTANCE OF PRESSED PRODUCTS OF 01420 ALLOY

Moscow METALLOVEDENIYE I OBRABOTKA METALLOV in Russian No 9, Sep 85, pp 55-58

BEREZINA, A. L., BELETSKIY, V. M., GUREVICH, T. N., TROFIMOVA, L. N. and CHUMAK, V. I.

[Abstract] A study was made of the influence of heat treatment conditions on the tendency of pressed shapes of 01420 Al-Mg-Li alloy toward intercrystalline and delamination corrosion as well as corrosion cracking. Structural studies were performed on light and electron microscopes, corrosion testing according to the State standards. The specimens were hardened in water from 450°C, held for 20 minutes, secondarily hardened at the same temperature in air and aged at 120°C for five hours. The electron microscope studies showed that segregation of S-phase particles depends strongly on the rate of cooling from 450°C, while slower cooling in air causing a great increase in

the number of grains whose boundaries are studded with compact S phase particles. Metallographic analysis showed that two-phase aging decreases the thickness of the surface large grain layer by approximately a factor of 3, the mean large grain size by a factor of 2 in comparison with standard heat treatment. Replacing secondary hardening with cooling in air by aging at a temperature near the upper boundary of the existence of the S phase and subsequent cooling in air can eliminate the negative influence of structural heterogeneity on corrosion resistance of this alloy. References 6: all Russian.

[19-6508]

UDC: 669.715'721'5.018.2:620.17

MECHANICAL PROPERTIES OF UNMODIFIED AND STRONTIUM-MODIFIED ALLOYS IN SYSTEM Al-Si-Zn-Mg-Ti

Moscow METALLOVEDENIYE I OBRABOTKA METALLOV in Russian No 9, Sep 85, pp 58-62

GANIYEV, I. N., SEMENOVA, O. N. and VAKHOBOV, A. V., Institute of Chemistry imeni V. I. Nikitin, Tadzhik Academy of Sciences; Chelyabinsk Tractor Plant imeni V. I. Lenin Production Association

[Abstract] A study is presented of the influence of composition and microalloying with strontium (0.05%) on the structure and properties of Al-Si-Zn-Mg-Ti system alloys containing 5-12% Si, 0-12% Zn, 0.25% Mg and 0.12% Ti. Graphs of mechanical strength as a function of composition are presented. Experimental data were used to calculate the coefficients of full cubic approximation models, and regression equations were derived. Strontium modification was found to increase the strength and ductility of the alloys by 10-20% in most cases. In the cast state, the greatest elongation is observed in alloys containing 6-9% silicon with small quantities of zinc. After heat treatment, the maximum ductility and relative elongation are seen in alloys containing 9-10% Si. References 4: all Russian.

[19-6508]

UDC: 621.762.5001

INFLUENCE OF ALLOYING ON PROPERTIES OF TUNGSTEN-COPPER PSEUDOALLOYS

Kiev POROSHKOVAYA METALLURGIYA in Russian No 7, Jul 85  
(manuscript received 13 Sep 84) pp 43-46

PANICHKINA, V. V., SIROTYUK, M. M. and PILIPOVSKIY, Yul L., Institute of Materials Science Problems, Ukrainian Academy of Sciences

[Abstract] A study is made of the influence of the addition of small quantities of active elements on the properties of W-20% Cu pseudoalloys when worked in an inert medium. The influence of these additives on wetting by copper of tungsten with oxides on its surface at 1350°C in a medium of argon was studied. Contact wetting angles were measured and work of adhesion calculated. The introduction of active additives greatly decreases the contact wetting angle, and increases the work of adhesion by a factor of two. The structural unity of the material was also improved, formation of strong contacts at the interface improving the interaction of the refractory phase with the copper and facilitating the appearance of a hydrostatic stress component in the pseudoalloy upon loading. Both the strength and ductility of the pseudoalloy were improved. References 8: 7 Russian, 1 Western.

[21-6508]

UDC: 669.3-14:669.017.3

INFLUENCE OF BORON AND CERIUM ON CAST STRUCTURE OF COPPER

Moscow IZVESTIYA AKADEMII NAUK SSSR: METALLY in Russian No 4, Jul-Aug 85  
(manuscript received 10 Jan 84) pp 117-121

CHERNOV, V. S., Kaluga

[Abstract] A study is made of the influence of boron and cerium in quantities of up to 0.5 mass percent on the cast structure of vacuum-smelted copper. Melts were produced in a vacuum resistance furnace at  $10^{-4}$  mm Hg in a graphite crucible. The metal was poured under a vacuum into a graphite mold 50 mm in diameter with a capacity of 1 kg. The temperature of the mold was varied by electric heating it from room temperature to 1000°C in order to regulate the cooling rate. Both elements had an effective modifying effect on copper, particularly in the area of maximum concentrations and particularly for cerium. The modification mechanism and structural specifics are explained on the basis of the concept of concentration compacting and supercooling in advance of the crystallization front. References 7: all Russian.

[23-6508]

UDC: 669.715'3'721:539.56

INFLUENCE OF DISPERSED TRANSITION METAL PARTICLES AND GRAIN STRUCTURE ON  
FRACTURE CHARACTERISTICS OF Al-Cu-Mg ALLOYS

Moscow IZVESTIYA AKADEMII NAUK SSSR: METALLY in Russian No 4, Jul-Aug 85  
(manuscript received 10 Mar 84) pp 150-155

DRITS, A. M. and KOPELOVICH, B. A., Moscow

[Abstract] A study is made of the influence of the addition of manganese and zirconium in moderate quantities on the structure and characteristics of static and fatigue crack resistance in Al-Cu-Mg alloys. The joint influence of Mn, Zr and scandium, producing a high density of coherent scandium particles in combination with noncoherent manganese and partially coherent zirconium particles, was also studied. The mechanical properties of the alloys, homogenized at 490°C for over 6 hours and rolled at 420°C, were determined. The strength characteristics of alloys with varying contents of manganese and zirconium were practically identical. Ductility and crack resistance were higher in alloys containing both manganese and zirconium, though increasing manganese content reduced ductility and impact toughness. Artificial aging slightly reduces fatigue and static crack resistance and ductility while increasing strength. Electron microscopic analysis showed that in alloys containing manganese or zirconium the dispersed particles are unevenly distributed, particularly, the manganese segregations. Introduction of manganese and particularly zirconium to alloys with scandium significantly reduces grain size and increases the density of aluminum-scandium phase segregations. Increasing the uniformity of distribution of the dispersed particles and the presence of polygonized structure decrease the grain boundary fracture sensitivity of the alloys following artificial aging. References 6:  
3 Russian, 3 Western.

[23-6508]

UDC: 669.24'855/.856:541.5

VALENCE OF CERIUM AND PRASEODYMIUM IN LIQUID ALLOYS WITH NICKEL

Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 60, No 1, Jul 85  
(manuscript received 4 Jul 84; in final form 23 Nov 84) pp 54-60

SOLODOVNIKOV, V. M., SANDRATSKIY, L. M., SINGER, V. V., RADOVSKIY, I. Z.  
and GELD, P. V., Urals Polytechnical Institute imeni S. M. Kirov

[Abstract] A method is presented for calculating the valence of liquid cerium and praseodymium in alloys with nickel within the framework of the Faber-Seiman-Evans theory. Stages in the calculation include determination of electron density of an isolated atom by self-consistent computation; construction of the electron density of the melt on this basis; utilization

of the electron density to determine the single-electron muffin-tin potential; use of the muffin-tin potential to solve the radial Schroedinger equation within the muffin-tin sphere; and determination of the energy variation of scattering phases. References 17: 10 Russian, 7 Western.  
[17-6508]

UDC: 669.71:539.372:537.311.31

**DEFORMATION MECHANISM OF SCATTERING AND DISTRIBUTION FUNCTION OF CONDUCTIVITY ELECTRONS IN ALUMINUM**

Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 60, No 1, Jul 85 (manuscript received 28 Dec 84) pp 71-76

GOSTISHCHEV, V. I., DEMYANOV, S. Ye. and SOBOL, V. R., Institute of Solid State Physics and Semiconductors, Belorussian Academy of Sciences

[Abstract] A detailed study is presented of the influence of electron-dislocation scattering on transfer in aluminum. Single-crystal and polycrystalline specimens of aluminum were deformed in compression and extension at low temperature, and then annealed at room temperature. The degree of deformation in extension was monitored with micrometer indicator with an accuracy of 0.01 mm. Resistivity was measured by a potentiometer at 4.2 to 30 K. The major dislocation mechanism in these experiments is dislocation slip along multiple planes. Low-angle scattering of electrons on long-distance voltage fields in the presence of a magnetic field significantly influences the distribution function of electrons, manifested as a nonlinear variation of matrix elements in the collision operator as a function of deformation defect concentrations. References 15: 8 Russian, 7 Western.  
[17-6508]

UDC: 669.3'6'871:669.112.227.346.2

**INFLUENCE OF INITIAL PHASE STATE ON KINETICS OF MARTENSITE CONVERSION IN CuSnGa ALLOYS**

Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 60, No 1, Jul 85 (manuscript received 15 Oct 84) pp 90-96

LOBODYUK, V. A. and SYCH, T. G., Institute of Metal Physics, Ukrainian Academy of Sciences

[Abstract] A study is presented of the influence of the initial phase state on the kinetics of martensite conversion in CuSnGa alloys with 22.5-24.0 wt.% Sn, 2.0 wt.% Ga with martensite point below -100°C, as well as a study of the influence of heat treatment on the martensite points, microhardness, structural state after hardening and holding at various temperatures between 100 and 200°C.

Martensite points were determined from the bend curves obtained by 3-point bending or the curves of the temperature variation of resistivity. The length of holding at a constant temperature of 100 or 150°C significantly influences the martensite points. Microhardness increases rather rapidly with holding time, then its increase slows, and at 100°C becomes constant with a further increase in holding time. The studies showed that isothermal conversion is most frequently observed in aged specimens. It is assumed that isothermal martensite conversion requires a certain level of strength of the material. It occurs in those cases when the microhardness is 3-4 GPa, which can be achieved by aging at 100-200°C. References 15: 14 Russian, 1 Western. [17-6508]

UDC: 669.296'293'71:620.186.1

INFLUENCE OF ALUMINUM ON STRUCTURAL CONVERSIONS OF BETA-SOLID SOLUTION IN ALLOY Zr-Nb-Al

Moscow FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 60, No 1, Jul 85  
(manuscript received 21 Dec 84) pp 199-201

ZAKHAROVA, M. I., BADAYEV, O. P., Moscow State University imeni M. V. Lomonosov

[Abstract] A study is made of the decomposition of an FCC beta-solid solution in an alloy containing (at.-%): 72.5 Zr + 15 Nb + 12.5 Al. The alloy was prepared in an arc furnace in purified argon with six-times remelting, hardened in oil from 1100°C and tempered in a vacuum of  $10^{-3}$  Pa. X-ray analysis of polycrystals and electron microdiffraction studies were performed. It was found that addition of aluminum to the Zr-Nb alloy resulted in characteristic conversion of structure with breakdown of the FCC beta-solid solution at 350 and 450°C: delamination of the beta-solid solution into two, one of which has ordered placement of atoms. An omega-phase is separated from the solid solution during tempering at 350 and 450°C, also with an ordered structure.

[17-6508]

UDC 669.822'6'25:538.22

CRYSTAL STRUCTURE AND MAGNETIC PROPERTIES OF INTERMETALLIC COMPOUND USnCo

Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 60, No 2, Aug 85 (manuscript received 28 Jan 85) pp 411-412

ANDREYEV, A. V., Ural State University imeni A. M. Gorkiy

[Abstract] First specimens of the new intermetallic compound USnCo were produced by melting its component elements on a copper tray in an electric-arc furnace in a helium atmosphere. Metallographic and x-ray examinations have revealed that this is a single-phase compound with a hexagonal crystal lattice of the Fe<sub>2</sub>P or, more precisely, ZrNiAl type. The magnetization characteristics of its polycrystalline specimens with [001] grain orientation and the hysteresis loop along the orientation axis were measured at 4.2 K temperature. The temperature dependence of its magnetic moment was measured with a vibromagnetometer, with the static external magnetic field of 1800 kA/m intensity first parallel and then perpendicular to the [001] axis, also with a parallel magnetic field of only 80 kA/m intensity. Measurements were made at 88 K temperature as well. The data indicate that the Hill distance between U atoms is larger in USnCo than in UGaCo and in UGaNi, much larger than critical and close to the optimum 0.38-0.40 nm, but the magnetic moment in USnCo is the same as in UGaNi. According to the results of this study, USnCo is a highly anisotropic uniaxial ferromagnetic material. The author thanks M. I. Bartashevich for assisting with the magnetic measurements. References 3: 2 Russian, 1 Western. [32-2415]

UDC 669.293'783:537.312.62

SUPERCONDUCTING TRANSITION IN Nb<sub>3</sub>Ge IRRADIATED IN SUPERCONDUCTING STATE

Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 60, No 2, Aug 85 (manuscript received 11 Jan 85) pp 409-411

ANDRONIKASHVILI, E. L., MASKIDASHVILI, I. A. and KVIRIKASHVILI, T. Sh., Institute of Physics, GSSR Academy of Sciences; TOPCHYAN, L. S., BRODSKIY, B. V., MAKARENKO, Ye. S. and BYCHKOV, Yu. F., Moscow Institute of Engineering Physics

[Abstract] An experimental study of the intermetallic compound Nb<sub>3</sub>Ge was made for the purpose of determining the effect of its neutron irradiation at a temperature below the superconducting transition point on that superconducting transition. Specimens of Nb<sub>3</sub>Ge, 2  $\mu$ m thick layers, were deposited on molybdenum wire 0.5 mm in diameter. They were placed in the cryogenic channel adjacent to the reactor core of a nuclear reactor using gaseous helium as coolant and there were exposed to a neutron flux of  $8 \cdot 10^{12} \text{ cm}^{-2} \text{ s}^{-1}$  intensity

(neutron energy 1 MeV or higher) at  $12 \pm 0.1$  K temperature. Temperature measurements with a Cu-Cu/Fe thermocouple were accurate within  $\pm 0.3$  K. For monitoring the superconducting transition, the electrical resistance was measured by the four-point potentiometric method and its temperature dependence was recorded with an automatic XY-plotter. The data indicate that at this irradiation level, causing the electrical resistance of molybdenum to increase by up to 60%, the S-N transition temperature drops only by 3.6% while the width of its range remains almost unchanged. Similar results had been obtained earlier with irradiation at 18-21 K, above the superconducting transition point. Accordingly, the character of the S-N transition in the superconducting composite material Mo-Nb<sub>3</sub>Ge does not depend on whether this material has been irradiated above or below that critical temperature. The authors thank the staff at the Institute of Physics (GSSR Academy of Sciences) working in the reactor plant and in the cryogenic plant as well as along the low-temperature loops. References 14: 5 Russian, 9 Western.

[32-2415]

UDC 669.71:539.216.2:669-156

#### POSSIBILITY OF QUENCHING ALUMINUM FILMS DURING LASER TREATMENT

Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 60, No 2, Aug 85 (manuscript received 26 Nov 84) pp 405-407

MARKEVICH, M. I. and CHAPLANOV, A. M., Institute of Electronics, BSSR Academy of Sciences

[Abstract] The temperature dependence of vacancy concentration in aluminum films has been calculated by the method of computer simulation for a given heating and cooling law. The film surface and the grain boundaries are treated as infinite-power vacancy sources during heating and constitute vacancy sinks during cooling. The mean number of jumps made by vacancies prior to their vanishment in sinks was calculated by the Monte Carlo method, with this number being determined by the sink concentration and thus the grain dimensions. The results indicate that drainage of vacancies by internal sinks is negligible, as compared with their absorption by the film surface and the grain boundaries. Further analysis, on this basis, of the vacancy behavior during treatment of aluminum films with laser pulses at various constant heating rates and at a threshold power just sufficient to heat the film to its premelting temperature indicates that there is a possibility of quenching such a film: at a sufficiently high heating rate ( $10^6$  K/s or higher), and with exponential cooling between pulses characterized by a cooling constant correspondingly of the order of  $10^3$  s<sup>-1</sup>, there is a critical temperature below which vacancies will not be absorbed by those external sinks but will migrate away from them. References 4: 3 Russian, 1 Western (in Russian translation).

[32-2415]

ANOMALIES IN THERMAL EXPANSION OF POLYCRYSTALLINE La, Pr, Nd OVER 290-970 K  
TEMPERATURE RANGE

Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 60, No 2, Aug 85  
(manuscript received 28 Aug 84, in final version 16 Nov 84) pp 398-400

FRIZEN, S. A., IVLIYEV, A. D., KATANOVA, L. K. and MOREVA, N. I.,  
Sverdlovsk Mining Institute imeni V. V. Vakhrushev

[Abstract] Thermal expansion of three rare-earth metals (La, Pr, Nd) was studied in an experiment, the purpose being to verify the stability of anomalies in the temperature dependence of their other physical properties such as thermal diffusivity. Relative elongation and differential linear expansion, referred to initial length at room temperature, were measured with a quartz dilatometer over the 290-970 K temperature range with the specimens heated up at a rate of 5 K/min. The cylindrical specimens 20 mm long and 4.5 mm in diameter contained 0.12 wt.% impurity (La) or 0.08 wt.% impurity (Pr, Nd), that impurity consisting of O<sub>2</sub>, N<sub>2</sub>, Fe, Cu, and companion rare-earth metals. The ratio of electrical resistivity at room temperature to electrical resistivity and at 4.2 K was, respectively, 6, 15, 12 for the specimens of La, Pr, Nd. The results reveal two anomalies in the form of deviations from a monotonic temperature dependence, the first one corresponding to restructurization from twin c.p.h. to f.c.c. crystal lattice with attendant abrupt decrease in size and the second one corresponding to a not-yet-understood phase transformation with no abrupt change in size. The latter transformation is most likely structural or electronic and not magnetic, inasmuch as magnetic disordering in light rare-earth metals occurs far below room temperature. Both anomalies correlate with the temperature dependence of thermal diffusivity. For lanthanum the first anomaly begins at 583 K, and the second anomaly occurs within the 700-800 K range. The ranges of analogous anomalies for praseodymium and neodymium are 580-850 K and 540-850 K respectively. The authors thank M. A. Danilov and O. A. Khomenko for assistance in measurements, also V. Ye. Zinov'yev for interest and creative discussions. Figures 3; references 13: all Russian.

[32-2415]

EFFECT OF PARTIAL BREAKUP OF  $\beta_1$ -PHASE ON MARTENSITE TRANSFORMATION IN  
Cu-Al ALLOYS WITH Mn, Co, Fe

Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 60, No 2,  
Aug 85 (manuscript received 23 Aug 84) pp 340-343

BUBLEY, I. R., YEFIMOVA, T. V., POLOTNYUK, V. V., TITOV, P. V. and  
KHANDROS, L. G., Institute of Metal Physics, UkrSSR Academy of Sciences

[Abstract] The effect of adding Mn, Co, Fe to Cu-Al alloys on their martensite transformation was studied since addition of any of these three elements is known to retard and complicate the breakup of the  $\beta_1$ -phase which exists in these alloys in the subcooled state. Ternary alloys Cu + 12-13% Al + 3-5% Mn and Cu + 12-13% Al + 1-2% Fe, as well as quinquenary alloys Cu + 12-13% Al + 3-5% Mn + 1% Fe + 1% Co, with the  $M_s$  point near room temperature or lower, were included in this study. Structural and phase analysis by x-radiography with an RKV-86 camera and a Cu  $K_{\alpha}$   $\gamma$  radiation source was supplemented with electrical resistance measurements for quantitative determination of martensite. Specimens were also tested for hardness and with a KM-0.5T pendulum for toughness. Heating to and holding at temperatures of 180-250°C was found to first lower and then raise the  $M_s$  point of all ternary alloys. The trend is different for the quinquenary alloys. Holding them at 180°C first slightly raises their  $M_s$  point of all ternary alloys. The trend is different for the quinquenary alloys. Holding them at 180°C first slightly raises their  $M_s$  point within 10 h, and then lowers it within the next 50 h with hardly any change afterwards. Holding them at 210°C has the same effect as on the ternary alloys. As the holding temperature is raised, first to 290°C and then 400-500°C, it accelerates the processes which change the  $M_s$  point and cause hysteresis of the martensite transformation. Hardness reaches a maximum while magnetization increases slightly, but the hysteresis of martensite transformation continues to increase with time to as much as 100°C. These trends in the quinquenary alloys are attributable to partial breakup of the  $\beta_1$ -phase, with precipitation of a  $\gamma$ -phase ( $Cu_2Al_4$ ). While Mn atoms distribute themselves in an ordered manner over the  $\beta_1$ -phase lattice and thus form a Heusler transition phase, Co and Fe atoms do not form groups but constitute segregation centers for aluminum and thus raise the  $M_s$  point after relative short holding at lower temperature (180°C) at which the  $\gamma$ -phase still does not precipitate. References 8: 7 Russian, 1 Western (in Russian translation).

[32-2415]

UDC 669.24'28:548.313.3:621.785.78

FORMATION OF REGULAR SPACE DISTRIBUTION OF TYPE-D1<sub>a</sub> ORDERED PHASE  
PRECIPITATING DURING AGING AND ORDERING OF Ni-Mo ALLOYS

Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 60, No 2, Aug 85  
(manuscript received 21 Aug 84) pp 334-339

POLYAKOVA, N. A., PLAKHTIY, V. D., NOSOVA, G. I., TYAPKIN, Yu. D. and  
ARZAMASOV, A. B., Institute of Metal Science and Metal Physics, Central  
Scientific Research Institute of Ferrous Metallurgy imeni I. P. Bardin

[Abstract] The space distribution of the  $\beta$ -phase in Ni-Mo alloys ( $\text{Ni}_4\text{Mo}$  phase) precipitating during aging and during ordering of these alloys was studied under an electron microscope, this  $\beta$ -phase having a type-D1<sub>a</sub> tetragonal structure. Two alloys were examined,  $\text{Ni} + 14.4$  atom.% Mo and  $\text{Ni} + 19.9$  atom.% Mo, Ni-Mo alloys differing structurally from Ni-Be and Cu-Be alloys. Dark-field images of foil specimens and their analysis on the basis of a base-centered-tetragonal macrolattice reveal that the distribution of this phase evolves into a regular one during tempering as well. A statistical analysis of electron-microscope images has confirmed that the model of multistep twinned tetragonal blocks is valid for Ni-Mo alloys as well as for Ni-Be and Cu-Be alloys. References 6: all Russian.  
[32-2415]

UDC 669.24'295'788:620.181

STRUCTURAL AND PHASE TRANSFORMATIONS CAUSED BY HYDROGEN IN TiN-BASE ALLOYS

Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 60, No 2,  
Aug 85 (manuscript received 22 May 84, in final version 1 Aug 84) pp 326-333

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[Abstract] Structural and phase transformations in TiN-base alloys resulting from the presence of hydrogen were studied by the method of x-ray analysis, among these alloys being binary ones ( $\text{Ti} + 50-50.7$  atom.% Ni) and two alloys also containing iron ( $\text{Ti} + 49.5$  atom.% Ni + 0.5 atom.% Fe,  $\text{Ti} + 49.5$  atom.% Ni + 3 atom.% Fe). All these alloys had been produced by triple smelting in a helium atmosphere. Ingots were rolled into 0.3-0.4 mm thick foil, and the latter, after being vacuum-annealed at 900°C for 1 h, was chemically polished into a 100  $\mu\text{m}$  thick layer with interstitial  $\text{O}_2$  and  $\text{N}_2$  impurities. This foil with a mirror surface was chemically hydrogenated in 4% aqueous solution of  $\text{H}_2\text{SO}_4$  at current densities ranging from 0.01 to 5 mA/mm<sup>2</sup> for lengths of time ranging from 5 min to 5 h. Specimens were analyzed in a DRON-2 x-ray diffractometer at room temperature (20°C) as well as at low temperatures (-50°C, -190°C). According to their phase composition, the binary TiN alloys fall in to two groups with phase

compositions B2 and B2 + B19' (B19' = 20-95% martensite) respectively before hydrogenation. The two alloys with iron have, respectively, R + B19' and B2 phase compositions before hydrogenation. Although the binary alloys may contain some R-phase with negligible rhombohedral split, it was not revealed on the x-rays. The  $M_s$  temperature of the binary alloys varies from +35°C to -5°C depending on the nickel content, it is 30°C for the TiN + 0.5 atom.% Fe alloys and -190°C for the TiN + 3 atom.% Fe alloy. The results of this study indicate that hydrogen entering these alloys in small amounts probably becomes distributed in them so as to further destabilize the already unstable B2 crystal lattice, as the  $T_R$  transformation temperature is approached by cooling. Its effect is thus equivalent to the effect of heating or stressing. Hydrogen can not only raise the temperature at which thermo-elastic martensite transformation begins but also induce such a transformation at a temperature far above the  $M_s$  temperature. It forms oriented martensite and induces in it a shape-memory effect during heating. References 9: all Russian.

[32-2415]

UDC 669.855:620.181

#### EMF PULSES OCCURRING DURING $\gamma \rightarrow \alpha$ TRANSFORMATION IN CERIUM

Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 60, No 2, Aug 85 (manuscript received 27 Jul 84, in final version 8 Nov 84) pp 285-289

KOKORIN, V. V. and CHERNENKO, V. A., Institute of Metal Physics, UkrSSR Academy of Sciences

[Abstract] An experimental study of isostructural (face-centered cubic)  $\gamma \rightarrow \alpha$  transformation in cerium under high pressure was made which revealed emf pulse signals carrying information about the transformation kinetics. Measurements were made on three specimens: 1) cylinder 17 mm high and 3.5 mm in diameter; 2) parallelepiped 3x1x0.5 mm<sup>3</sup>; 3) parallelepiped 6x1x0.5 mm<sup>3</sup>. They were annealed for 8 h under a vacuum of 10<sup>-12</sup> GPa at 770 K inside a quartz container. Specimen 3 was deformed prior to measurements. Specimen 1 was used for measurement of volume and its temperature dependence over the 273-450 K range at constant pressures, by the dilatometric method. Specimen 2 was used for electrical resistance measurements by the standard four-point method, with the pressure raised from 0.4 to 1.5 GPa at a rate of 0.8 GPa/min and dropped from 1.5 to 0.4 GPa at a rate of 0.1 GPa/min. The accompanying emf signal was measured with a V2-25 d.c. microvoltmeter through copper leads which had been welded to the specimen and brought out from the pressure chamber. A recording PDP-4 potentiometer revealed also low-frequency and high-frequency emf signals. The low-frequency signals were analyzed on an N-306 oscilloscope with time sweep, for determination of their amplitude and duration. High-frequency signals of microsecond and millisecond durations were analyzed on an S1-48B oscilloscope. The temperature was varied at a constant rate of 10 K/min for volume and electrical resistance measurements, at a variable 0.5-10 K/min rate for emf measurements. The results

suggest a thermoelectric mechanism of emf generation during  $\gamma$ - $\alpha$  transformation, magnetism not being a likely factor in this paramagnetic material and shock waves interacting with interfaces boundaries not likely to be produced in this relatively plastic material. References 11: 6 Russian, 5 Western.  
[32-2415]

UDC 669-492.2:539.216:538.22

#### MAGNETIC PROPERTIES OF AMORPHOUS $TbFe_2$ AND $TbCo_2$ POWDERS

Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 60, No 2, Aug 85 (manuscript received 5 Jan 84, in final version 26 Nov 84) pp 290-294

BARINOV, V. A., YURCHIKOV, Ye. Ye. and YERMAKOV, A. Ye., Institute of Metal Physics, Ural Science Center, USSR Academy of Sciences

[Abstract] A study of  $TbFe_2$  and  $TbCo_2$  compounds was made, for the purpose of determining the structural changes and attendant changes in magnetic properties as a result of comminution into powder. A stoichiometric relation between the elements in these compounds was ensured by mixing grade TBM-1 terbium with 99.99% pure carbonyl iron or K-0 electrolytic cobalt, then melting with iron in an argon atmosphere in an induction furnace and with cobalt as a suspension in a liquid. Diffractograms of the Lawes phases revealed similarities between these compounds and the  $YCo_2$  compound, but other measurements revealed differences. Mössbauer spectra of  $TbFe_2$  at various stages of its comminution at room temperature revealed nuclear-gamma resonance. Both  $TbFe_2$  and  $TbCo_2$  were found to have anomalous magnetization characteristics at 4.2 K and at 290 K, respectively, owing to random magnetic anisotropy of the magnetic  $Tb^{3+}$  ion. The magnetization was also found to become less temperature-dependent, decreasing less with rising temperature, with increasing length of crushing time and thus in successive stages of comminution. The magnetization generally decreases with increasing comminution, according to measurements at various intensities of the magnetizing field over a period of 30 h of crushing time. The temperature of magnetic transformation is much lower in the amorphous state than in the original crystalline state, dropping from 700 K to 400 K for  $TbFe_2$  (390 K for amorphous  $TbFe_2$  film deposited by vacuum evaporation). References 10: 3 Russian, 7 Western (1 in Russian translation).

[32-2415]

/9835

## NON-METALLIC MATERIALS

UDC: 666.1.031.2

### UNIVERSAL FLAME TRANSFER SYSTEM

Moscow STEKLO I KERAMIKA in Russian No 7, Jul 85 pp 5-6

ALEKSEYEV, R. M., GORDEYEV, V. A., LOZHECHNIKOV, V. I. and PALIY, Ye. P., Engineers, Rosavtomatstrom Special Planning and Design Technical Association

[Abstract] Contactless systems have been developed for transfer of flame in regenerative glass-making furnaces. The authors' organization has been involved in the development and introduction of contactless flame transfer systems for furnaces operating with various types of fuel for some years. Analysis of existing flame transfer systems showed that they have various primary sensors monitoring the positions of the shifting mechanisms and various activating devices. The authors have now developed a universal flame transfer system, the control unit for which consists of a timer, instruction generating unit, flame transfer control module and relay module, each of which is briefly described. The device can operate automatically, semi-automatically or manually. In the automatic mode, flame transfer is timed. The unit has good noise immunity, is universal in terms of input devices and activating mechanisms it can work with, and has the advantages of standardization.

[25-6508]

UDC: 666.1.031:666.76.5

### ZIRCONIUM REFRactories FOR GLASSMAKING

Moscow STEKLO I KERAMIKA in Russian No 7, Jul 85 pp 6-8

MELNIKOVA, I. G., Candidate of Chemical Sciences, NESTEROVA, T. A. and RAZDOLSKAYA, I. V., Engineers, State Optical Institute imen'i S. I. Vavilov

[Abstract] Zirconium refractories are widely used in technology, glass-making consuming some 80% of all zirconium and zirconium-containing materials. This review of the Soviet and Western literature describes the chemistry and utilization of refractories, typically containing 67.2%  $ZrO_2$  and 32.8%  $SiO_2$ . Zirconium-containing refractories are particularly well suited to the production of glass with low alkali content.

References 11: 9 Russian, 2 Western.

[25-6508]

UDC: 666.155.5

## EFFECTIVE CONDITIONS FOR PRESSING THIN TRIPLEX GLASS IN AN AIR AUTOCLAVE

Moscow STEKLO I KERAMIKA in Russian No 7, Jul 85 pp 11-12

KOPYLOV, O. M., PLAKSINA, Engineers, and BOGATYREV, L. S., Candidate of Technical Sciences, All-Union Scientific Research Institute of Technical Construction Glass

[Abstract] A method has been developed for pressing thin triplex 4.1-5.9 mm thick in an industrial air-filled autoclave. The duration of the process has been reduced from 120 to 75-95 minutes and the pressure reduced from 1.4-1.5 to 0.6-1.2 MPa. The experimental glass-making plant of the authors' institute has manufactured specimens of flat triplex 600 x 900 mm from glass 1.65-2.6 mm thick and PVB film 0.76 mm thick with a film moisture content of 0.4-0.6%. Of 152 specimens manufactured, 92-94% were suitable for use. PVB film to glass adhesion was 6.3-7.8 MPa. The authors also studied the adhesion of the film to glass in curved sections, finding it to be 14-20% less than in the central flat sections of vehicle windshields. Use of the new method has allowed an increase in productivity of the autoclave at a glass-making plant by 17%, yielding an economic effect of 180,000 rubles per year.  
[25-6508]

UDC 666.76:546.281'261]:669.162.212.2

## REFRACTORIES MADE OF SiC FOR LINING SHAFTS IN BLAST FURNACES

Dnepropetrovsk METALLURGICHESKAYA I GORNORUDNAYA PROMYSHLENNOST in Russian No 2, Apr-Jun 85 pp 47-49

PITAK, N. V., FEDORUK, R. M. and KHMELENKO, T. P., Ukrainian Scientific Research Institute of Refractory Materials

[Abstract] A comparative study of SiC refractories with  $Si_3N_4$  binder and with  $Si_2ON_2$  binder for lining shafts in blast furnaces was made, the purpose being to determine their resistance to the aggressive action of various slag components. Specimens of these refractories in the form of 25x25x25 mm cubes were buried in an 80:20 mixture of coke and potash, inside corundum containers covered with mortar on clay base so as to keep out oxygen. They were tested in a blast furnace with slag consisting of 29.2 wt.%  $SiO_2$ , 8.08 wt.%  $Al_2O_3$ , 2.41 wt.%  $Fe_2O_3$ , 12.96 wt.%  $FeO$ , 38.6 wt.%  $CaO$ , 2.82 wt.%  $MgO$ , 0.9 wt.%  $K_2O+Na_2O$ , and 1.54 wt.% S. Argon was blown into the furnace during the experiment. The results indicate a performance of these refractories superior to that of ShPP-41 chamotte. They are immune to water vapor at 543-840°C and only slightly hygroscopic (0.3%) at 1°C. While  $Si_2ON_2$  binder is more resistant than  $Si_3N_4$  binder to alkalis in  $CO_2$ , it is less resistant than  $Si_3N_4$  binder to hydrogen: it decomposes at 1580°C in a hydrogen atmosphere, reducing to  $Si_3N_4$  but also releasing volatile  $SiO$  and free  $Si$  which forms a  $SiO_2$  coating film. References 4: 2 Russian, 2 Western.  
[20-2415]

WEAK FIELD DIMENSIONAL MAGNETORESISTANCE IN PLATES OF ELECTRONIC SILICON  
ORIENTED IN PLANE (100)

Leningrad FIZIKA I TEKHNIKA POLUPROVODNIKOV in Russian Vol 19, No 6,  
Jun 85 (manuscript received 13 Aug 84; accepted to press 18 Dec 84) pp 987-992

BERIDZE, B. Sh., KLIMOVSKAYA, A. I., PRIMA, N. A. and SNITKO, O. V.,  
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[Abstract] The purpose of this work was to determine the length and time of energetic and inter-valley relaxation in a single experiment and explain the causes of divergence of results presented by different authors. This was done by studying the anisotropy of dimensional magnetic resistance in weak electric and magnetic fields. It was found that there is an orientation of specimens for which the dimensional effect is primarily manifested in the energetic length, while there is another for which it is manifested in inter-valley relaxation. This allows both lengths to be determined in a single experiment. It was also found that anisotropy of magnetic resistance in silicon depends strongly not only on the contribution of dimensional effects, but also on pulse scattering mechanisms, so that a slight contribution of impurity scattering influences the lengths determined in the experiment. The differences in lengths determined by different methods are related primarily to the approximate nature of the equations used to process experimental data, a factor which is particularly important in pure specimens for which simple phenomenologic equations require significant corrections. Equations used in this article partially considered the difference in distribution functions in the valley from Maxwellian distribution.

References 12: 10 Russian, 2 Western.

[3-6508]

MECHANISM OF INTERACTION OF AREAS OF ACCUMULATION OF DEFECTS FORMED BY  
HIGH ENERGY PROTONS WITH POINT DEFECTS IN GERMANIUM

Leningrad FIZIKA I TEKHNIKA POLUPROVODNIKOV in Russian Vol 19, No 6,  
Jun 85 (manuscript received 3 Jan 84; accepted to press 20 Dec 84)  
pp 993-997

POKOTILO, Yu. M. and YAVID, V. Yu., Scientific Research Institute of  
Applied Physics Problems imeni A. N. Sevchenko, Belorussian State  
University imeni V. I. Lenin, Minsk

[Abstract] In order to establish the mechanism of interaction of point defects and areas of accumulation of defects (AAD), the recombination properties of Ge <Sb> containing AAD in various concentrations, formed by protons with an energy of 660 MeV were studied upon subsequent additional bombardment with gamma quanta from  $^{60}\text{Co}$ . Life times were determined by measurements of the steady photomagnetic effect. Analysis of the experimental results show that a change in recombination properties of AAD occurs not as a result of the direct interaction of point defects and AAD as in Si

and Ge bombarded by neutrons, but rather indirectly through an electron subsystem due to a change in the position of the Fermi level in the matrix and AAD upon gamma irradiation. References 12: all Russian.  
[3-6508]

#### TEMPERATURE DEPENDENCE OF AMPLITUDE-FREQUENCY CHARACTERISTICS OF PHOTOCONDUCTIVITY IN SEMICONDUCTOR WITH TWO-LEVEL IMPURITY (Ge:Hg)

Leningrad FIZIKA I TEKHNIKA POLUPROVODNIKOV in Russian Vol 19, No 6, Jun 85 (manuscript received 19 Dec 84; accepted to press 24 Dec 84)  
pp 1008-1011

KURBATOV, V. A., PENIN, N. A. and SOLOVYEV, N. N., Physics Institute imeni P. N. Lebedev, USSR Academy of Sciences, Moscow

[Abstract] It is difficult to obtain analytic expressions for the amplitude-frequency characteristics of semiconductors considering several types of capture centers for any photoresponse amplitudes; the authors therefore studied the case of small, variable photosignals, for which the system of nonlinear differential equations describing the behavior of the multilevel model can be reduced to a system of linear differential equations. This study was performed for a p-type semiconductor containing a two-level acceptor impurity. AFC were measured in germanium specimens doped with mercury and with antimony as a donor impurity. Equations are derived for determination of the capture cross-section of nonequilibrium holes by mercury ions over a relatively broad range of temperatures. The capture cross-section was found to depend on temperature approximately as  $T^{-n}$ , where n equals approximately 1, for both singly and doubly ionized mercury ions. The capture cross-section for doubly ionized ions is significantly less than that for singly ionized mercury. References 7: 6 Russian, 1 Western.  
[3-6508]

#### CHANGE IN ELECTROPHYSICAL PROPERTIES OF STRONGLY DOPED p-SILICON LAYERS ON SAPPHIRE BOMBARDED WITH NEUTRONS

Leningrad FIZIKA I TEKHNIKA POLUPROVODNIKOV in Russian Vol 19, No 6, Jun 85 (manuscript received 29 Aug 84; accepted to press 28 Dec 84)  
pp 1017-1020

KOBA, B. V., LITVINOV, V. L., OCHERETYANSKIY, A. L., STUCHEBNIKOV, V. M., UKHIN, N. A., FEDOTOV, I. B., KHASIKOV, V. V. and CHERNITSYN, V. N., "Teplopribor" State Scientific Research Institute, Moscow

[Abstract] A study is presented of changes in resistivity, concentration and Hall mobility of holes in strongly doped layers of silicon on sapphire after neutron bombardment. Layers 2-4 micrometers thick with an initial concentration of holes of  $5 \cdot 10^{18}$ - $2 \cdot 10^{20} \text{ cm}^{-3}$  were studied, bombarded in a reactor at

50-70°C, with thermal neutrons cut off by a cadmium cover. Differences from less highly doped specimens included specifics of the radiation damage, featuring primary formation of complexes consisting of a doping impurity plus a primary radiation defect. Cascades of displacements created by fast neutrons were simple defects or specific impurity-defect damage areas differing from the double vacancy areas observed in less highly doped specimens. References 15: 7 Russian, 8 Western.  
[3-6508]

#### LOCAL STATES LIMITING DRIFT MOBILITY IN VITREOUS SELENIUM WITH ADDITION OF S, Te and As

Leningrad FIZIKA I TEKHNIKA POLUPROVODNIKOV in Russian Vol 19, No 6, Jun 85 (manuscript received 18 Oct 84; accepted to press 4 Jan 85)  
pp 1035-1038

BARANOVSKIY, S. D. and LEBEDEV, E. A., Physical Technical Institute imeni A. F. Ioffe, USSR Academy of Sciences, Leningrad

[Abstract] An analysis is presented of experimental data on the drift mobility of charge carriers in vitreous selenium containing S, Te and As, indicating that if atoms of substances in which the sigma orbital is higher in energy than the same orbital in selenium are added to selenium and the LP orbital is lower than the LP orbital of selenium, the tails of the zones are determined by the orbitals of selenium and do not significantly change. Otherwise, if the corresponding orbitals of the added atoms fall in the slot of selenium mobility, the presence of the additive strongly influences the tails of state densities and, consequently, the drift mobility of the charge carriers. The experimental data indicate a zonal origin of localized states, limiting the drift mobility in this material. References 19:  
10 Russian, 9 Western.  
[3-6508]

#### PHOTOELECTRIC PROPERTIES OF LIQUID SELENIUM WITH In AND Ge ADDITIVES

Leningrad FIZIKA I TEKHNIKA POLUPROVODNIKOV in Russian Vol 19, No 6, Jun 85 (manuscript received 27 Dec 84; accepted to press 17 Jan 85)  
pp 1074-1077

AYVAZOV, A. A. and BUDAGYAN, B. G., Moscow Electronic Engineering Institute

[Abstract] Measurements were performed of the steady longitudinal photoconductivity and photo-emf in liquid selenium doped with elements of group III (In) and IV (Ge). Specimens were formed of materials with purity at least 99.999% in evacuated quartz ampules which are held at 650°C for 24 hours in a rotating reactor. Content of impurities was tested by atomic absorption analysis with an accuracy of  $10^{-3}$  at.%. Spectral variation of longitudinal photoconductivity and photo-emf was studied in the range of 1.8-2.8 eV from

the melting point of hexagonal selenium to 570 K. The impurities do not change the basic charge carrier type in liquid selenium which are holes. Addition of In reduces photoresponse current and shifts quantum yield toward higher photon energies, while Ge has no significant influence on hole photocurrent. Activation energies of the process are determined, indicating localization of impurities at the ends of chains, changing the concentration and energy position of charge defects centers in liquid selenium.

References 7: 4 Russian, 3 Western.

[3-6508]

#### NEGATIVE MAGNETORESISTANCE IN TWO-DIMENSIONAL ELECTRONIC GAS AT SURFACE OF GERMANIUM

Leningrad FIZIKA I TEKHNIKA POLUPROVODNIKOV in Russian Vol 19, No 6, Jun 85 (manuscript received 17 Oct 84; accepted to press 22 Jan 85) pp 1100-1103

GUSEV, G. M., KVON, Z. D., KORCHAGIN, A. I., NEIZVESTNYY, I. G. and OVSYUK, V. N., Institute of Semiconductor Physics, Siberian Branch, USSR Academy of Sciences, Novosibirsk

[Abstract] Negative magnetic resistance is discovered and studied in a two-dimensional electron gas at the surface of Ge. Specifics related to filling of overlying subzones are discovered. Experimental specimens were n-channel MDS transistors on the (111) surface of Ge based on  $\text{Ge-SiO}_2\text{-Si}_3\text{N}_4$  and  $\text{Ge-GeO}_2\text{-Si}_3\text{N}_4$  structures. The theory of quantum conductivity corrections fully describes the negative magnetoresistance. Characteristic relaxation times of the wave function phase are found as a function of temperature and surface excess of charge carriers in a channel. References 16: 5 Russian, 11 Western.

[3-6508]

/9835

## PREPARATION

UDC 539.011.23:539.216

### FLUCTUATIONS IN AND STABILITY OF METALLIC GLASS

Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 60, No 2, Aug 85 (manuscript received 20 Sep 84) pp 250-254

AKHIYEZER, I. A., DAVYDOV, L. N. and SPOLNIK, Z. A., Kharkov Physical Technical Institute, UkrSSR Academy of Sciences

[Abstract] The crystallization temperature of a metallic glass is related to the temperature  $T_f$  at which fluctuations of its single-particle energy  $\delta_\epsilon$  freezes, the probability of their freezing being characterized by the distribution  $w_f = e^{-\delta_\epsilon/T_f}$ , and to its melting point. After it has been calculated on this basis from the interatomic paired interaction potential, it serves as criterion for determining the yield strength and the stability of such a material under a mechanical load. This requires first determining the change of crystallization temperature under a mechanical load, in this case as that of the upper limit for existence of the glassy phase. Both temperature ranges below and above the lowest possible crystallization temperature are considered, this temperature corresponding to the theoretical ultimate strength of the material and the yield strength not being temperature-dependent below it but becoming temperature-dependent above it. These ranges correspond, respectively, to heterogeneous and homogeneous flow, with no range of heterogeneous flow existing when that lowest possible crystallization temperature is lower than zero, and in both ranges the threshold stress decreases as a square-root function of the temperature as the crystallization point is approached. References 6: 2 Russian, 4 Western.

[32-2415]

UDC: 669.187.2:621.744:536.421.1.001.57

NUMERICAL STUDY OF ELECTRODE MELTING AND INGOT FORMATION IN ELECTRIC SLAG REMELTING

Kiev PROBLEMY SPETSIALNOY ELEKTROMETALLURGII in Russian No 3, Jul-Aug-Sep 85  
(manuscript received 12 Dec 83) pp 10-14

MAKHnenko, V. I., SKOSNYAGIN, Yu. A., BOCHARNIKOV, I. V. and GLADKIY, Ye. D.,  
Institute of Electric Welding imeni Ye. O. Paton, Ukrainian Academy of  
Sciences, Kiev

[Abstract] The purpose of this study was to determine the nature of the influence of various factors on the melting rate of a consumable electrode in the electric slag remelting process. Modeling was performed using data obtained as melts were produced in two crystallizers. The modeling assumed uniform ambient temperature and a slag temperature equal to its temperature after casting into the crystallizer. The initial shape and temperature of the electrode were assumed known. The feed rate of the electrode was selected to maintain constant spacing between the end of the electrode and the surface of the ingot. Calculations were performed for various initial electrode and slag temperatures with all other conditions remaining constant. The mathematical model of melting of the electrode and the calculation algorithm developed were tested by comparing calculation results with experimental data. References 3: all Russian.

[15-6508]

UDC: 669.187.2:046.546.2:532.7.005

THEORETICAL ANALYSIS OF STEEL DESULFURATION KINETICS IN ELECTRIC SLAG REMELTING

Kiev PROBLEMY SPETSIALNOY ELEKTROMETALLURGII in Russian No 3, Jul-Aug-Sep 85  
(manuscript received 25 May 83) pp 19-22

MEDZHIBOZHSKIY, M. Ya., MEDOVAR, B. I., RAZINKIN, B. I., REBROV, L. V.,  
BOGACHENKO, A. G. and SHTANKO, Yu. P., Institute of Electric Welding  
imeni Ya. O. Paton, Ukrainian Academy of Sciences, Kiev; Zhdanov Metallurgical  
Institute

[Abstract] In previous works, the kinetics of desulfuration upon remelting of a single consumable electrode of relatively small cross-section were studied. At present, multiple-electrode electric slag furnaces are in service, and it is now possible to obtain new experimental data supplementing previous knowledge concerning the kinetics of desulfuration during electric slag remelting. This study indicates that, due to a low concentration of sulfur in the metal, the process of desulfuration is limited to diffusion of sulfur in the boundary layer of the metal in contact with the slag. As the liquid metal moves downward through the slag layer, its sulfur content decreases as the contact surface of metal with slag increases. Equations are

derived for computation of the quantity of sulfur removed from the metal. Good agreement with experimental data is achieved. References 10: all Russian. [15-6508]

UDC: 669.187.2:66.097

#### USE OF ELECTROCHEMICAL CELLS TO TEST THE LEVEL OF OXIDATION OF A SLAG MELT IN THE PROCESS OF ELECTRIC SLAG REMELTING

Kiev PROBLEMY SPETSIALNOY ELEKTROMETALLURGII in Russian No 3, Jul-Aug-Sep 85 (manuscript received 22 Oct 84) pp 22-24

ISTOMIN, V. A., CHERKASOV, P. A., KASHIN, V. I. and KARPOV, O. S., Institute of Metallurgy imeni A. A. Baykov, USSR Academy of Sciences, Moscow

[Abstract] A study is made of the possibility of testing the oxidation potential of a slag melt in the process of electric slag remelting by the electromotive force method. Two types of electrochemical cells differing in the material used, were tested. In one cell the solid electrolyte was fused Al2O3, in the other it was ZrO2 stabilized with yttrium oxide. The solid electrolyte was protected from erosion by the liquid slag by covering its surface with platinum foil 0.05 to 0.1 mm thick. The efficiency of the cell was studied and the oxidation potential of the slag melt measured in a laboratory electric slag furnace which used line frequency alternating current. The electrochemical cell design presented is judged to allow long-term measurement of the slag bath oxygen pressure. The use of such cells will allow studies of the oxidation-reduction reactions occurring between liquid metal and slag melt. References 2: 1 Russian, 1 Western. [15-6508]

UDC: 669.187.2:002.5:620.9.001.5

#### ELECTRIC SLAG MELTING IN POWER MACHINE BUILDING

Kiev PROBLEMY SPETSIALNOY ELEKTROMETALLURGII in Russian No 3, Jul-Aug-Sep 85 (manuscript received 27 Jun 83) pp 24-29

KRIGER, Yu. N., NECHAYEV, Ye. A. and KARPOV, O. S., Scientific-Production Association Section, Central Scientific Research Institute of Machine Building Technology, Chekhov

[Abstract] Electric slag casting allows the production of complex shaped castings for large and important machine parts. The technology, developed at the Institute of Electric Welding imeni Ye. O. Paton, produces high-quality parts with very small machining allowances, with many surfaces requiring no additional working. Electric slag parts combine the good service properties of forged metal with the low metal consumption characteristic of castings. A technology has been developed and introduced for

production of the body parts of steam turbines of type 15Kh1M1FSH steel. Photographs are presented of some very large parts (mass up to 5,000 kg) produced by the process. The economic characteristics of the process for various types of steels are represented in tabular form. References 7: all Russian.

[15-6508]

UDC: 669.187.2:533.9:669.295

USE OF PLASMA-ARC TECHNOLOGY IN PRODUCTION OF TITANIUM INGOTS FROM TITANIUM PRODUCTION WASTES

Kiev PROBLEMY SPETSIALNOY ELEKTROMETALLURGII in Russian No 3, Jul-Aug-Sep 85 (manuscript received 6 Jun 84) pp 65-70

LATASH, Yu. V., KONSTANTINOV, V. S., GALKIN, P. N., CHVERTKO, A. I., SHAPOVALOV, V. A., ROGATKIN, A. A., REYDA, N. V., ZILBER, L. M. and DZHONS, M. M., Institute of Electric Welding imeni Ye. O. Paton, Ukrainian Academy of Sciences, Kiev; Zaporozhye Titanium-Magnesium Combine; Institute of Titanium, Zaporozhye

[Abstract] The advantages of plasma-arc remelting for utilization of titanium wastes are noted. Joint efforts by the authors' institutes have resulted in introduction of a plasma-arc furnace for melting of ingots from noncompact titanium charge at a metallurgical plant. The furnace produces ingots 270 and 300 mm in diameter and 2500 mm in length using a charge consisting of titanium sponge, sheet and lump scraps. The device uses alternating current to supply the plasmotrons, thus avoiding magnetic interaction among the plasmotron arcs. Operation of the furnace is described. The product produced by the furnace is of satisfactory quality. References 6: all Russian.

[15-6508]

UDC: 669.283.7

STUDY OF POSSIBILITY OF IODIDE REFINING OF MOLYBDENUM

Moscow IZVESTIYA AKADEMII NAUK SSSR: METALLY in Russian No 4, Jul-Aug 85 (manuscript received 19 Jan 84) pp 29-34

KLIMENKO, G. L., Moscow

[Abstract] Thermodynamic studies were performed of the interaction of Mo, W, V, Cr, Ca, Al, K, Na, Mn, Fe, Sb, Pb, Cd, Cu and Ni with iodine and molybdenum diiodide. The thermodynamic properties of the iodides were used to calculate the Gibbs energy of the reactions of the formation of iodides. Calculations were performed using 1 g-mol of iodine in the 298-1200 K

temperature range. It is concluded that elementary iodine at 400 K is better iodized by metallic Ca, K, Na, Al, V, Mn, Fe and Cd. The reaction forming Pb and Cr iodides occurs less completely. The reaction with Mo, W, Sb, Ni and Cu is even less complete. As temperature increases, iodination is less eager, and at 1000 K, Mo, Pb, W, Sb, Cd, Cr, Ni and Cu are practically impossible to iodize. Equilibrium partial pressures of hydrogen iodide are calculated for reduction of iodides by hydrogen at 400, 700 and 1000 K. Heat treatment of  $\text{MoI}_2$  at 373-973 K and  $<5 \cdot 10^{-2}$  mm Hg results in purification of impurity elements from most volatile iodides.  $\text{MoI}_2$  partially sublimates at 1033-1068 K in a dynamic vacuum. References 12: 10 Russian, 2 Western. [23-6508]

UDC: 669.054.2

#### EFFECTIVENESS OF CRYSTALLIZATION PURIFICATION OF ANTIMONY, BISMUTH, TELLURIUM AND CADMIUM

Moscow IZVESTIYA AKADEMII NAUK SSSR: METALLY in Russian No 4, Jul-Aug 85 (manuscript received 29 Feb 84) pp 35-41

MARYCHEV, V. V., Moscow

[Abstract] Repeated zone melting can purify many substances almost arbitrarily. A device has been developed for continuous zone melting and tested in the purification of antimony, bismuth and tellurium. The device is particularly convenient for laboratory and experimental production of highly pure materials. Recommendations are developed for conversion of oxidized impurities to elementary impurities by melting and distillation in a reducing medium. A method combining zone melting with repeated oxidative refining is suggested. Bismuth with a  $\gamma$  ratio of 700 to 1200 is produced, cadmium with over 80,000 and tellurium with a concentration of charge carriers of not over  $5 \cdot 10^{13} \text{ cm}^{-3}$  at 77 K are obtained. References 9: all Russian. [23-6508]

UDC: 669.872+669.871-154:669.046.5

#### CONVECTIVE MIXING UPON ELECTRON TRANSFER IN MELTED WIRE SPECIMENS OF INDIUM AND GALLIUM HELD BY OXIDE FILM

Moscow IZVESTIYA AKADEMII NAUK SSSR: METALLY in Russian No 4, Jul-Aug 85 (manuscript received 1 Jun 83) pp 42-45

MIKHAYLOV, V. A., SHCHUKIN, L. I., DRAKIN, S. I., ANKUDIMOVA, I. A., ZELENKINA, N. I., NECHISTYAK, T. A. and ILINYKH, O. V., Moscow

[Abstract] Studies were performed on indium containing bismuth impurity and gallium containing silver impurity. Wires of the substances were obtained

and purified by electrodiffusion of the wires in the liquid state, held in place by the solid oxide films formed upon oxidation in the air. Current was passed through the melted wires for 48 to 72 hours which was sufficient to achieve a steady-state distribution of the impurities. The effective diffusion coefficient was studied as a function of current density and capillary diameter. The convective component of the effective diffusion coefficient was found to be proportional to the square of current density and the cube of capillary diameter. The method was shown to be effective for deep purification of the wire elements. References 11: all Russian. [23-6508]

UDC: 669.245:620.17

#### INFLUENCE OF CHEMICAL COMPOSITION AND STRUCTURE OF NICKEL ALLOYS ON THEIR SUITABILITY AS PRESSURE VESSEL MATERIALS

Moscow IZVESTIYA AKADEMII NAUK SSSR: METALLY in Russian No 4, Jul-Aug 85  
(manuscript received 12 Jan 84) pp 99-107

KAPUSTIN, N. V. and BANNYKH, O. A., Moscow

[Abstract] An estimate is presented of the relationship between suitability of nickel alloys as materials for the manufacture of high-pressure vessels and the mechanical properties of the alloys in order to simplify selection of an alloy for operation at pressures of up to 10 kbar and temperatures up to 750°C. Studies were performed on alloys with various degrees of heat resistance, which is basically determined by the content of the hardening  $\gamma'$  phase in the alloys. The strength of fine-grained alloys was found to be 10 to 15% higher than that of large-grained alloys. The best usage properties were found in EP-455A hardened from 1080°C, which has excellent strength and ductility in the temperature range of interest. It is the strength and ductility characteristics which determine the usability of the nickel alloys in the manufacture of high-pressure vessels. Alloys with moderate contents of  $\gamma'$  phase (up to 30 mass percent), containing titanium and aluminum in order to achieve rounded  $\gamma$  phase particles and cobalt to facilitate retention of usage properties at high temperatures, are desirable. The alloy should have a structure as isotropic as possible with minimum grain size and noncontinuous segregation of carbides on the grain boundaries.

References 15: 12 Russian, 3 Western.

[23-6508]

UDC: 669.255:532.213:539.52

SUPERPLASTICITY OF AMORPHOUS COBALT-BASED ALLOYS

Moscow IZVESTIYA AKADEMII NAUK SSSR: METALLY in Russian No 4, Jul-Aug 85  
(manuscript received 4 Aug 83) pp 156-158

ZELENSKIY, V. A., TIKHONOV, A. S., deceased, KOBYLKIN, A. N. and  
SITNIKOV, D. N., Moscow

[Abstract] A series of tensile tests was performed on the amorphous metal alloy  $Co_{168}Fe_7Ni_{13}Si_7B_5$  at 500 to 640°C and deformation rates of  $10^{-5}$  to  $10^{-2} s^{-1}$  in order to determine conditions providing for the appearance of the maximum ductility of the alloy. The temperature interval of crystallization was determined by differential thermal analysis with heating rates of 1.0, 25.0 and 45.0°C/min. The tensile test temperature range was selected to correspond to the transition temperature from the amorphous to the crystalline state. Structural studies were performed on an electron microscope. It is found that a 20-25°C below the maximum crystallization rate of the amorphous alloy, superplasticity is observed, manifested as a drop in deformation resistance and an increase in ductility. The electron microscope studies show that these temperature conditions correspond to an intermediate crystallization state which should feature the most developed surface of crystal seeds in the amorphous matrix. References 4: 2 Russian, 2 Western. [23-6508]

/9835

TREATMENTS

UDC: 621.78.063:536.12

COOLING CAPACITY OF AQUEOUS SOLUTION OF PK-2 POLYMER AT VARIOUS TEMPERATURES

"Moscow METALLOVEDENIYE I OBRABOTKA METALLOV in Russian No 9, Sep 85, pp 2-5

KOBASKO, N. I., SHVETS, Yu. I., FIALKO, N. M., MERANOVA, N. O. and NIKOLAYEV, Ye. D., Institute of Technical Thermophysics, Ukrainian Academy of Sciences, Experimental Design-Technological Office with Experimental Production Facility of Thermophysical Instrument Building; Institute of Technical Thermophysics, Ukrainian Academy of Sciences

[Abstract] Results are presented from a study of the cooling capacity of an aqueous solution of PK-2 polymer, a solution of iron-containing polyacrylic acid salts with neutralizing components added, used in the hardening of metals. Particular attention is paid to a study of the influence of the temperature of the polymer medium on its hardening properties. The cooling capacity of a hardening medium is described by a combination of parameters, including particularly the heat transfer coefficient and heat flux density at the part surface. These parameters are found by solving quasi-inverse heat conductivity problems. Experimental and calculated data are used to determine the influence of temperature of the aqueous 1% PK-2 polymer solution on its cooling capability. Increasing the temperature of the medium decreases the intensity of cooling during hardening. The variation of various characteristics of the medium as functions of temperature of the aqueous polymer solution are determined. As the medium temperature increases, the critical heat flux density decreases and duration of all stages in hardening cooling increases. Other parameters determining the effectiveness of heat transfer are also changed. References 3: all Russian.

[19-6508]

UDC: 621.774:621.783:621.365.5

## HEAT TREATMENT OF PIPE WITH THICKENED ENDS IN INDUCTION DEVICE

Moscow METALLOVEDENIYE I OBRABOTKA METALLOV in Russian No 9, Sep 85, pp 10-13

ZGURA, A. A. and TYAZHELNICKOV, A. I., All-Union Scientific-Research and Design-Technological Institute of the Pipe Industry, Dnepropetrovsk

[Abstract] Parameters of the operation of an industrial induction installation were determined in order to develop recommendations for the creation of improved installations of this type. Studies were performed on an experimental batch of pipe made of steel type 28Kh2MFBD, including heat for hardening to  $130+30^{\circ}\text{C}$ , heating for tempering to  $690+20^{\circ}\text{C}$ , for pipe with an outer diameter 127 mm, wall thickness of smooth portion of pipe 10 mm, wall thickness of end portion 20 mm, and length of thicker portion 200 mm. It is found that when pipes are induction-heated for hardening, preliminary heating should be to  $750-800^{\circ}\text{C}$  immediately before heating in the induction unit. When heating for tempering, the ends of the pipes should also be heated at  $280-360^{\circ}\text{C}$ . In order to eliminate nonuniform temperatures over the length of the smooth portion of the pipe caused by variations in wall thickness, after the heating section there should be a temperature equalization section up to 30% of the length of the main heating line. Curvature of pipes does not occur during heating for hardening. Pipes may be curved by cooling sprayers in case water flow rate is not uniform.

[19-6508]

UDC: 621.78-97:669.131.7

## LOW-TEMPERATURE HEAT TREATMENT OF PARTS OF HIGH-STRENGTH CAST IRON

Moscow METALLOVEDENIYE I OBRABOTKA METALLOV in Russian No 9, Sep 85, pp 63-64

ULANOVSKAYA, S. N., MONASTYRSKAYA, N. N., VANZHA, G. K. and YAROSHENKO, V. I.

[Abstract] The purpose of this work was to select a heat treatment producing the necessary mechanical properties of cast iron with spheroidal graphite. The microstructure and mechanical properties of cast iron specimens with an initial ferrite matrix and the following chemical compositions were studied: 2.93-3.34% C, 3.52-4.67% Si, 0.84-1.13% Mn, 0.003-0.008% S, 0.034-0.048% P, 0.03-0.06% Mg. High-temperature heat treatment ( $920-950^{\circ}\text{C}$ ) helps to increase the strength characteristics of the cast iron but does not always produce the required toughness and ductility. Holding for five hours at  $725^{\circ}\text{C}$  increase both strength and ductility. Spheroidization annealing (heating to  $725^{\circ}\text{C}$ , holding for 2.5 hours, cooling with the furnace to  $500^{\circ}\text{C}$ , then further cooling in air) increases the time of thermal diffusion of silicon but reduces the effect of reverse microlquation of silicon, decreasing impact toughness.

Low-temperature heat treatment at 725°C is recommended instead of higher-temperature heat treatment for casting of parts from this alloy.  
References 2: both Russian.  
[19-6508]

UDC: 621.762.4

#### STRUCTURE AND PROPERTIES OF POWDERED MATERIAL SHAPED BY HOT STAMPING WITH EXTRUSION ELEMENTS

Kiev POROSHKOVAYA METALLURGIYA in Russian No 7, Jul 85  
(manuscript received 1 Aug 84) pp 23-27

DOROFEEV, V. Yu., Novocherkassk Polytechnical Institute

[Abstract] Cold-pressed billets with about 20% porosity were preliminarily sintered at 1000°C for one hour in dissociated ammonia. After heating to 1100°C for 10 minutes, the billets were pressed in a die on a crank press. Shear and tensile strength testing of specimens was performed after deformation. Shear strength depended neither on the system of formation of the specimens nor on annealing temperature, indicating that the change in orientation of nonmetallic inclusions and pores in extrusion did not essentially change the metallic cross-section of the specimens. Extruded specimens did show higher tensile strength. Inclusion of elements of extrusion in deformation improved the physical properties of the specimen due to a reduction in pore size and favorable orientation of metal grain, nonmetallic inclusions and remaining pores. The tensile strength of materials based on iron powder was increased by up to 40% and ductility by up to 100%. References 2: both Russian.

[21-6508]

UDC: 621.762.4.01:669.017.13

#### EXPLOSIVE PRESSING OF TiC-TiNi COMPOSITE POWDERS

Kiev POROSHKOVAYA METALLURGIYA in Russian No 7, Jul 85  
(manuscript received 27 Apr 84) pp 27-31

PANIN, V. Ye., SLOSMAN, A. I., OVECHKIN, B. B., BONDAR, M. P. and KOSTYUKOV, N. A., Tomsk Polytechnical Institute

[Abstract] A study is made of the consolidation of powdered TiC-TiNi composites during explosive pressing and subsequent sintering, and the advantages of the method in comparison to the traditional technology of production of hard alloys by uniaxial pressing and free sintering are estimated. Powders of titanium carbide with irregularly shaped particles up to 15  $\mu\text{m}$  in size and powders of titanium mononickelide produced by

calcium hydride reduction with sizes of up to 20  $\mu\text{m}$  were used in the studies. Powder composition was 50:50 by mass. Explosive pressing was performed in a cylindrical steel container 175 mm high, with an inside diameter of 15 mm using hexogen with sodium chloride inert component in various mass ratios surrounding the container of powder mixture. Pressings with relative density up to 95% were achieved as opposed to 70% by static pressing. The optimal sintering temperature was found to be 150°C lower than the optimal temperature for static pressing, allowing sintering virtually without any liquid phase present. Plasticizers need not be used, simplifying preparation of powders. The grain structure was finer and flexural strength greater than for statically pressed specimens. References 4: 3 Russian, 1 Western.  
[21-6508]

UDC: 669.018.95

#### SATURATION OF TITANIUM CARBIDE AND DIBORIDE-BASED CERAMETS WITH METAL MELTS

Kiev POROSHKOVAYA METALLURGIYA in Russian No 7, Jul 85  
(manuscript received 20 Jun 84) pp 58-62

KITSAY, A. A., TSYGANNOVA, T. V. and ORDANYAN, S. S., Leningrad Institute of Technology

[Abstract] The purpose of this work was to study the saturation kinetics of sintered titanium carbide and diboride-based ceramets with excess quantities of metal binder. Sintered cermet specimens measuring 5 x 2 x 40 mm were placed in pairs in a charge of corrax heated to 1970 K. A pressing of the saturated metal was placed between the preliminarily protected sides of the specimens. The entire arrangement was then placed in a furnace, heated to the necessary temperature and held in a vacuum. Specimens with nickel-molybdenum and nickel binders most actively absorb the liquid. Specimens with the composition 75% TiC - 19% Fe - 6% Ni absorb the liquid more slowly and at higher temperatures due to the lower solubility of titanium carbide in the 7% Fe - 25% Ni liquid than in nickel or nickel-molybdenum binder. Active absorption of additional quantities of melted metal occurs with restructuring of the solid phase framework and an increase in volume of the specimen, which can be used as an indicator of the intensity of the process. The composition of the binder can be varied to regulate the intensity of the framework restructuring process and distribution of cementing phase in the product of the process. Increasing preliminary sintering temperature decreases intensity of framework restructuring upon subsequent contact with the liquid metal. Processes of diffusion equalization of the metal binder composition predominate over laminar melt flow in this process.

References 12: all Russian.  
[21-6508]

UDC: 621.793.75:733.9

MECHANICAL PROPERTIES OF PLASMA-FILLED COATINGS OF ZIRCONIUM BORIDE, COPPER AND THEIR COMPOSITES

Kiev POROSHKOVAYA METALLURGIYA in Russian No 7, Jul 85  
(manuscript received 15 Mar 82) pp 78-81

LOSKUTOV, V. S. and DEKHTYAR, L. I., Scientific Research Institute of Introscopy

[Abstract] Results are presented from mechanical testing of gas-thermal coatings of zirconium boride and copper and their composites, produced from  $ZrB_2$  and Cu powders with particle sizes of 50-100 and 50-63  $\mu m$ , respectively, plus mechanical mixtures of them prepared in a barrel mixer over 2 to 3 hours. The materials were dried at 400 K for 2 to 5 hours before application by an M8-27 sprayer with a nozzle diameter of 7 mm using a disk-type feeder which minimized the segregation of particles in the mixture. The coatings were applied to a polished base and then peeled off for tensile strength testing. The influence of copper on the short-term strength of the composite coating was studied. It was found that increasing copper content increased the strength. A coating with 25-30% Cu had the greatest Young's modulus. Density varies linearly with copper content. References 6: all Russian.

[21-6508]

UDC: 669.35.017/.018:671.1

DEVELOPMENT OF COPPER ALLOY WITH DESIRED COLOR PROPERTIES

Moscow TSVETNYYE METALLY in Russian No 8, Aug 85, pp 93-97

MAYORENKO, V. M., FEDOROV, V. N. and LAVRENT'YEV, M. I.

[Abstract] The color of metal is determined by the variation of reflectivity from its surface as a function of incident light wavelength. Experimental alloys were produced in a graphite crucible in a high frequency induction furnace beneath a layer of flux. Flat specimens were ground, polished, annealed in a protective medium, then further polished to class 9 or 10 surface smoothness and washed in alcohol. Color properties were determined with a spectrophotometer. None of the bronze and brass specimens met the condition of being identical in reflectivity as a function of wavelength to jeweller's gold. The results indicated, however, that an alloy of 4-8% Zn, 0.4-0.7% Al, 0.1-0.3% P, remainder copper, should be quite similar in appearance to gold. An experimental batch of the alloy was produced and used to manufacture rings, brooches, chains and other jewelry products without galvanic gold plating but with colorless organic varnish coating. The results in terms of appearance were quite satisfactory. References 12: 9 Russian, 3 Western.

[16-6508]

UDC: 669.35:621.77

DECREASING METAL LOSS IN PRODUCTION OF ROLLED PRODUCTS

Moscow TSVETNYYE METALLY in Russian No 8, Aug 85, pp 97-98

BUROV, A. V.

[Abstract] The loss of nonferrous metals in rolling can be greatly reduced by systematically improving the quality of rolled and drawn products and carefully reducing their metal consumption. The major factors of metal loss are shortcomings in the organization and planning of measures to decrease metal consumption, imperfection of individual standards for rolled and drawn products, insufficient monitoring of processes and insufficient material interest in results produced. Steps suggested include revision of standards for rolled and drawn products, attestation of all types of products, development of plans for reducing metal consumption for the twelfth Five-Year Plan, systematic instruction of representatives of the industry to concentrate on saving metal, creation of groups consisting of representatives of scientific institutes and ferrous metallurgical plants to study the problem and development of methodological instructions for calculation of economic effectiveness of the reduction of metal consumption in rolled and drawn products for the industry.

[16-6508]

UDC: 669.295.5:621.771

COMPARISON OF QUALITY OF BARS OF VT3-1 ALLOY PRODUCED BY LONGITUDINAL AND HELICAL ROLLING

Moscow TSVETNYYE METALLY in Russian No 8, Aug 85, pp 101-103

KOROBSHCHIKOV, V. G., CRITSENKO, Yu. P. and SHAPIRO, V. Ya.

[Abstract] A study is made of some aspects of the introduction of helical rolling of bars of titanium alloys. The mechanical properties and some service characteristics of bars 55 mm in diameter of VT-1 alloy produced by rolling using various technological systems from 13 mm diameter stock are studied. Methods included longitudinal rolling with deformation in the beta temperature area in 8 passes, longitudinal rolling with the last 3 phases in the alpha-plus beta area, and helical rolling in the beta area. Results indicate that bars made by all of the methods tested meet the State standards. The microstructure of bars produced by longitudinal rolling in the beta area and helical rolling is identical (type 7-8), while that of bars obtained by longitudinal rolling in the alpha plus beta area is type 4-5. The microstructure of bars obtained by longitudinal rolling in the beta area has larger grain and is less homogeneous than that of bars obtained by the other two methods. The highest value of KCT is that of bars

produced by helical rolling. The endurance limit of bars produced by helical rolling is equal to that characteristic of longitudinal rolling in the alpha plus beta area. References 3: all Russian.  
[16-6508]

UDC: 669.715:621.77

#### HIGH SPEED PRESSING OF DIFFICULTLY DEFORMABLE ALUMINUM ALLOYS

Moscow TSVETNYYE METALLY in Russian No 8, Aug 85, pp 103-106

ZAKHAROV, V. V., KUKUSHKIN, Yu. N., TSAREV, A. I. and FISENKO, I. A.

[Abstract] A study is made of the possibility of increasing the flow rate in pressing of difficultly deformable aluminum alloys D16 and V95 by the use of heterogenization annealing of ingots and subsequent pressing at lower temperatures. A lubricant was used to reduce the temperature rise during pressing. Continuously cast ingots 134 mm in diameter were cut and turned into blanks 125 mm in diameter and 300 mm long, which were then heat treated by homogenization or heterogenization annealing. The blanks were then pressed by a semicontinuous method at low temperatures with VTS63 lubricant, producing bars 35 mm in diameter as well as T-shapes with wall thickness 8 and 3 mm. The process was found to greatly increase flow rates, while maintaining the structure and mechanical properties in full accordance with the State standards. References 16: 15 Russian, 1 Western.

[16-6508]

UDC: 669.715:620.187

#### INFLUENCE OF CAST BLANK STRUCTURE ON POROSITY OF THIN ALUMINUM FOIL

Moscow TSVETNYYE METALLY in Russian No 8, Aug 85, pp 108-109

AGEYEVA, G. N. and KOLTSOVA, M. A.

[Abstract] A study was performed to determine the influence of the structure of the initial cast blank on the formation of porosity in aluminum foil. Cast blanks obtained by ingotless rolling and semicontinuous casting from technical aluminum containing about 0.3 mass percent Fe were rolled by the standard technology to thicknesses of 14 and 7 micrometers and the frequency and size of pores determined. The greatest total porosity was that of foil produced from an ingot. The density of pore accumulations and their density of placement across the width of the foil differed less. The greater fraction of larger segregations in the foil obtained from the ingot resulted in a significant increase in total surface porosity. Some segregations do not reduce foil quality, and these harmless segregations are more common in foil produced by the ingotless rolling method. Fine dispersion

of structure, particularly crystallization-origin structural elements, has a favorable influence on foil quality. References 6: 3 Russian, 3 Western. [16-6508]

UDC: 669.71:62-492.3:669.168

#### PRODUCTION OF GRANULATED ALUMINUM FOR THE MANUFACTURE OF FERROALLOYS

Moscow TSVETNYYE METALLY in Russian No 8, Aug 85 pp 112-113

VOSKOBONYIK, M. I., SOLOVYEV, N. M., KOPYRIN, I. A., CHEREPANOV, V. P., CHERNEGA, N. I. and TITOV, V. I.

[Abstract] An installation which cooled granules in water was developed to produce granulated secondary aluminum type AV-86 to be used as a reducing agent in the aluminothermic production of ferroalloys. The capacity of the unit was 2-3 tons per hour. Melted aluminum was fed through a trough into a rotating perforated distributor cup placed within a conical tank with a layer of spinning water created on the inner walls. The granules, after crystallization and cooling in the layer of water, were dropped into a centrifuge for removal of moisture from the granulate and then dried. Testing of the granules in the manufacture of ferroalloys yielded unsatisfactory results due to the significant oxidation and large size of the granules. However, replacement of up to 50% of the aluminum powder with the granules in the production of ferroalloys yielded good results. The question of complete replacement of the powder with granules remains open, requiring further development of the granulation technology and the technology of the production of ferroalloys.

[16-6508]

UDC: 622.74

#### SCREENING OF FINELY GROUND DIAMOND-CONTAINING ORES IN AQUEOUS MEDIUM

Moscow TSVETNYYE METALLY in Russian No 8, Aug 85, pp 113-115

KOROVNIKOV, A. N., VAYSBERG, L. A. and LARIONOV, N. P.

[Abstract] A modernized screen design with a screening surface area of 1.5 m<sup>2</sup> was used to classify finely ground diamond-containing ores. Specifications of the GVP-1.0A vibration screen are presented. The throughput is 1.5-10.0 tons of solid per hour through the single 1 x 1.5 m screen. After traveling over the screen immersed in water, the product which does not go through the screen reaches a portion of the screen which is above the water, where it is partially dewatered and unloaded. The service life of the slot-type screen is 1800-2000 hours. References 7: all Russian.

[16-6508]

UDC: 622.7:622.342.1

USE OF CENTRIFUGAL APPARATUS TO EXTRACT FINE GOLD FROM PLACER SAND

Moscow TSVETNYYE METALLY in Russian No 8, Aug 85, pp 116-118

MANKOV, V. M. and LOPATIN, A. G.

[Abstract] The use of centrifugal apparatus to beneficiate gold-bearing sand can reduce the loss of fine-particle gold by a factor of 1.5-2.0, while reducing the limit of extracted gold particle size to 0.01-0.005. A promising technology for gravitational beneficiation has been developed on the basis of the use of centrifugal apparatus, including classification of sand by particle size, separate beneficiation of classification products on jigging machines and concentration stages, and the use of short-cone, improved short-cone centrifugal apparatus and centrifugal separators. Commercial testing of the technology was undertaken by a dredge working a clayey placer deposit. Most complete extraction was achieved for gold particles larger than 0.25 mm (95-100% extraction). Extraction decreased with decreasing particle size. References 3: all Russian.

[16-6508]

UDC: 669.187.2:621.78.004.13.001.5

SELECTION OF HEAT TREATMENT CONDITIONS FOR SHAFT-PINION BLANKS OF TYPE 40Kh STEEL PRODUCED BY ELECTRIC SLAG CASTING

Kiev PROBLEMY SPETSIALNOY ELEKTROMETALLURGII in Russian No 3, Jul-Aug-Sep 85 (manuscript received 24 May 85) pp 31-34

IPATOV, A. K., BONDARENKO, L. I. and YANKOVSKIY, V. F., Bolshevik Production Association of Polymer Machine Building, Kiev

[Abstract] The authors' organization has developed and improved a technology for producing shaft-pinion blanks of type 40Kh steel by electric slag casting. Studies have been performed at the central laboratory to determine causes of poor hardenability of type 40KhSh steel and develop heat treatment conditions for the shaft-pinion blanks to meet the requirements for properties of the material. The studies included tests of the chemical composition of the materials of electrodes and blanks, studies of the macrostructure and microstructure of the metal in the cast state, studies of microstructure and hardness of specimens after heat treatment by various methods and selection of the best heat treatment conditions. A table lists the types of heat treatment used and includes photomicrographs of the microstructure of the steel following the heat treatments. Conditions suggested include normalization at 900°C with hardening from 900°C and multistage cooling in water and oil; and hardening from 900°C with cooling in oil, followed by hardening from 900°C with multistage cooling in water and oil. Heating for tempering should be to 520°C with subsequent cooling in water or oil. Reference 1: Russian.

[15-6508]

UDC: 669.187.2:621.793.14-620.1

**THERMAL FATIGUE STRENGTH OF MULTICOMPONENT CONDENSED COATINGS ON ZhS6U ALLOY**

Kiev PROBLEMY SPETSIALNOY ELEKTROMETALLURGII in Russian No 3, Jul-Aug-Sep 85  
(manuscript received 15 Feb 84) pp 39-44

KURIAT, R. I., KRAVCHUK, L. V., BUKSKIKH, K. P. and MALASHENKO, I. S., Institute of Strength Problems, Ukrainian Academy of Sciences, Kiev; Institute of Electric Welding imeni Ye. O. Paton, Ukrainian Academy of Sciences, Kiev

**[Abstract]** A study is presented of the thermal cycle durability of cast nickel alloy ZhS6U with multicomponent Me-Cr-Al-Y coatings in a gas current based on the criterion of resistance to cyclic unsteady thermal loads. Coatings included Ni-Cr-Al-Y, Ni-Co-Cr-Al-Y and Co-Cr-Al-Y, containing 20-22% Cr and 11-11.5% Al. Before the coatings were applied to the wedge-shaped specimens, they were heated by an unfocused electron beam to 850°C. Condensation time was 25-35 minutes with layer thickness of the coating at the edge of the wedge up to 120 micrometers. Finish working included primary annealing in a vacuum at 1020°C for 2 hours, shot peening of the protected layer with 175-200 micrometer diameter spheres and final annealing at 1030-1040°C for 3 hours. The test timing was determined by the time required to stabilize the crack growth rate in the specimen. The maximum effect of increasing durability of the alloy was achieved by electron beam precipitation of Co-Cr-Al-Y coatings in a vacuum. A 5 to 6 times increase in material durability was achieved in comparison to the unprotected alloy. Thermal fatigue resistance was found to depend strongly on homogeneity of chemical composition of the coating through its thickness and the dispersion of structural components of the coating, substrate temperature, carefulness of surface preparation and rate of precipitation of the vapor. References 6: 4 Russian, 2 Western.

[15-6508]

UDC: 669.187.2:537.533:546.65:543.432

**SPECTROPHOTOMETRIC DETERMINATION OF YTTRIUM IN CHROMIUM-CONTAINING CONDENSATES OBTAINED BY ELECTRON BEAM EVAPORATION**

Kiev PROBLEMY SPETSIALNOY ELEKTROMETALLURGII in Russian No 3, Jul-Aug-Sep 85  
(manuscript received 2 Feb 84) pp 50-54

BABARIK, A. I., Institute of Electric Welding imeni Ye. O. Paton, Ukrainian Academy of Sciences, Kiev

**[Abstract]** A study is presented of the interaction of yttrium and chromium with arsenazo III in buffer solutions made with acetic and malonic acids or

urotropin, as well as unbuffered systems. The data obtained allow a method to be developed for spectrophotometric determination of yttrium in chromium-containing condensates of electron-beam evaporation without preliminary separation. The results of determination of yttrium in chromium-containing vacuum condensates of various chemical compositions indicate sufficient accuracy and reproducibility of the method. The relative error of an individual determination is not over 7%. The mean relative error of 3 to 4 parallel experiments is not over 3%. Error dispersion is random. References 7: all Russian.

[15-6508]

UDC: 669.187.2:533.9.047

#### PLASMA STEEL MAKING PROCESSES (REVIEW)

Kiev PROBLEMY SPETSIALNOY ELEKTROMETALLURGII in Russian No 3, Jul-Aug-Sep 85 (manuscript received 8 Oct 84) pp 55-60

OKOROKOV, G. N., Central Scientific Research Institute of Ferrous Metallurgy imeni I. P. Bardin, Moscow

[Abstract] The Central Scientific Research Institute of Ferrous Metallurgy, the leading organization in the USSR Ministry of Ferrous Metallurgy, has concluded that the use of plasma heating in the production of steel is promising. The task at present is to determine which processes specifically should be developed, and in what proportions, and which scientific-technical and organizational problems must be solved. This article discusses several processes and trends in the development of plasma metallurgy. Processes discussed include plasma melting in furnaces with ceramic crucibles, plasma remelting in furnaces with crystallizers, including plasma-arc remelting and vacuum-plasma (electron-plasma) remelting, and plasma-induction melting. The advantages of plasma furnaces with ceramic crucibles using AC or DC and the promise of development of furnaces of either type are considered questionable but worthy of detailed study. The energy costs of vacuum-plasma remelting and particularly plasma-arc remelting are somewhat higher than vacuum-arc remelting and electric slag remelting, but the advantages of the processes may at times compensate the higher cost by allowing the use of less expensive metals as raw materials, by an increase in the yield of usable metal or in cases where the production of a high quality product is impossible by other means. The USSR is the world leader in the development of plasma steel making processes. In the future specialized shops should be created for plasma steel making in ceramic crucible furnaces and for the more progressive processes of small scale metallurgy, i.e., vacuum and open-plasma-induction melting, plasma-arc and vacuum-plasma remelting. References 4: all Russian.

[15-6508]

UDC: 621.373.826:669.246

LASER HARDENING OF WORKING SURFACES OF HARD-ALLOY HIGH-PRESSURE EQUIPMENT PARTS

Kiev SVERKHTVERDYYE MATERIALY in Russian No 4, Jul-Aug 85  
(manuscript received 18 Jul 84) pp 9-12

RYZHOV, E. V., Kiev, AVERCHENKOV, V. I., NADUVAYEV, V. V., GORLENKO, O. A.  
and FROLOV, Ye. N., Bryansk Institute of Super Hard Materials, Ukrainian  
Academy of Sciences; Bryansk Institute of Transport Machine Building

[Abstract] The service life of a high-pressure device dies can be increased by laser hardening. The authors utilized the 'Kvant-16' laser installation to apply a series of laser radiation pulses in a 4 mm spot to the surfaces of hard materials, causing the development of various surface defects. Hardening conditions were found to depend on the overlap factor of adjacent laser beam spots (0.5 in this study) and the condition of the surface of the die when laser radiation was applied. Metallographic studies with an optical microscope were used to determine structurally altered zones of the surface. Any surface contamination or lubricant present on the die surface was found to reduce the laser hardening effect. References 6: all Russian.  
[22-6508]

UDC: 021.923:621.911.34

CUTTING CAPACITY OF A WHEEL FOR DIAMOND GRINDING OF SILICIDED GRAPHITE

Kiev SVERKHTVERDYYE MATERIALY in Russian No 4, Jul-Aug 85  
(manuscript received 13 Aug 84) pp 47-49

GRABCHENKO, A. I., Khar'kov, ZALOGA, V. A. and RYZHAKOV, S. K., Sumy Kharkov  
Polytechnical Institute; Sumy Branch, Kharkov Polytechnical Institute

[Abstract] A study is made of the possibility of diamond grinding of type SG-P 0.5 silicided graphite both by the usual method and with control of the cutting relief of the wheel. Control of the cutting relief of the diamond wheel is found not only to provide a higher value of the cutting capability factor, but also to stabilize this factor. Without cutting relief control, the cutting capability factor decreases greatly in the first four minutes of cutting. Increases in the cutting capability of diamond wheels for grinding of silicided graphite are achieved by continuous electrochemical removal of binder from the cutting surface, increasing the number of active cutting edges and reducing friction between the binder and the material being worked. Cutting relief control increases the cutting capability of diamond wheels for silicided graphite by a factor of 3 to 5. References 2: both Russian.  
[22-6508]

SENDUST PRODUCTION TECHNOLOGY IMPROVEMENTS

Kiev POROSHKOVAYA METALLURGIYA in Russian No 7, Jul 85  
(manuscript received 30 Jan 84) pp 62-67

REVNIVTSEV, V. I., LUKYANOVA, N. A., ZAROGATSKIY, L. P. and DENISOV, G. A.,  
All Union Scientific Research and Planning Institute of Mechanical  
Processing of Minerals

[Abstract] The precision alloy called sendust allows the density of magnetic recordings on high coercivity tape to be increased by an order of magnitude due to its high magnetic permeability and saturation induction, zero magnetostriction, high wear resistance and Curie point. The technology of manufacture of the material determines its properties to a large extent. The most promising technologies are based on powder metallurgy. The authors' institute has developed a new technology based on forced self-pulverization of the material within layers under the influence of vibration. The material produced was tested in the core of a monolithic video tape recorder head and produced good results. References 7: 6 Russian, 1 Western. [21-6508]

/9835

## WELDING, BRAZING AND SOLDERING

UDC: 621.762:621.791.3:621.793

### USE OF COATINGS TO PREPARE PART SURFACES FOR SOLDERING

Kiev POROSHKOVAЯ METALLURGIЯ in Russian No 7, Jul 85  
(manuscript received 29 Oct 84) pp 51-53

KARPINOS, D. M., ZILBERBERG, V. G., KIRKUN, N. I., VYALTSEV, A. M. and  
NEZHENTSEV, Yu. I., Institute of Material Sciences Problems, Ukrainian  
Academy of Sciences

[Abstract] The authors' institute has studied the possibility of soldering materials which are difficult to solder with coatings of various compositions. Aluminum specimens were prepared by applying coatings of metals which are easily soldered or by melting with subsequent introduction of easily soldered metals to the melt. The coating materials used included copper and nickel. Mathematical statistical processing of experimental data was used to determine average values and root-mean-square deviations in studies of the strength of soldered joints produced in coated materials, demonstrating the possibility in principle of soldering many materials by applying coatings of materials which are easily soldered to those which are more difficult to solder. References 3: all Russian.

[21-6508]

UDC: 621.791.052:621.7.044.2

### EXPLOSIVE TREATMENT OF WELDED JOINTS

Kiev AVTOMATICHESKAYA SVARKA in Russian No 7, Jul 85  
(manuscript received 7 Feb 85) pp 1-7

PETUSHKOV, V. G., Doctor of Technical Sciences, Corresponding Member,  
Ukrainian Academy of Sciences, KUDINOV, V. M., Institute of Electric  
Welding imeni Ye. O. Paton, Ukrainian Academy of Sciences

[Abstract] A study is made of some examples of the use of explosive treatment of welded joints to improve the service characteristics of metal structures. The influence of explosive treatment on the tendency toward brittleness in alkaline media was studied using flat welded specimens

measuring 500 x 500 x 6-30 mm of St3 steel in a boiling (120°C) aqueous solution of nitrates over a test length of 500 hours. The use of explosive treatment to increase resistance to sulfide cracking of circular seams in pipes of type 20 steel intended for the transportation of natural gas containing hydrogen sulfide was studied on pipes 168 x 14 mm by testing of model containers at 56.6 and 40 MPa internal pressure. Local explosive treatment of welded joints can relieve residual stresses by the creation of stresses oriented in the direction of the external force to be resisted. Explosive treatment can both improve fatigue resistance and increase the resistance of welded joints to brittle failure. Local explosive treatment of welded joints is found to increase their corrosion resistance in both alkaline and hydrogen sulfide media, fatigue strength, and resistance of joints to brittle fracture, even when crack defects are present, and to facilitate conservation of stress concentrators, slowing or stopping the development of brittle and fatigue cracks. References 30: 25 Russian, 4 Western, 1 East European.  
[24-6508]

UDC: 621.791.75.011:[621.774.1:621.74.042]:669.14.018.44

STUDY OF WELDABILITY OF HEAT-RESISTANT ALLOYS 40KhN35B, 40KhN48V and 15KhN34B FOR CENTRIFUGALLY CAST PIPE AND DEVELOPMENT OF SEAM COMPOUNDS

Kiev AVTOMATICHESKAYA SVARKA in Russian No 7, Jul 85 pp 26-31

YUSHCHENKO, K. A., Doctor of Technical Sciences, PINCHUK, N. I., Candidate of Technical Sciences, NAKONECHNYY, A. A., Engineer, Institute of Electric Welding imeni Ye. O. Paton, Ukrainian Academy of Sciences, BEGMA, D. G., Candidate of Technical Sciences, and GRZHEBALSKAYA, V. N., Engineer, All-Union Scientific Research and Design-Technological Institute of the Pipe Industry

[Abstract] The weldability of domestically produced high-carbon-iron-nickel alloys was evaluated following a suggestion by the USSR Ferrous Metals Ministry, and a welding material was developed for mechanized welding of high-carbon iron-nickel alloys with 35-48% Ni for use in centrifugal casting of pipes. Alloys 40KhN35B and 40KhN48V contain 0.40-0.45% C, while 15KhN34B contains 0.15-0.20% carbon. Studies were performed on specimens 300-400 mm in length cut from the middle and end of pipe sections. All specimens had compact metal with a structure characteristic of centrifugal casting; finer grain at the outside surface and some increase in crystal size in the middle portion of the pipe. Rolling tests showed that increasing silicon content to 1.8% did not reduce the deformability of the alloy as was expected, but rather improved it. A study was made of the possibility of increasing the silicon content in the welding wire to 3% while maintaining the manganese content and adding boron, magnesium, cerium and aluminum to the wire. The alloy with 0.32% silicon showed unsatisfactory deformation properties. Increasing silicon to over 2.3% makes deformation difficult. The tests performed

showed satisfactory weldability of the metals and demonstrated the possibility of mechanized welding. Joints were close in strength to the parent metal when tested at 900 and 1000°C for long-term strength. References 8: all Western.  
[24-6508]

UDC: 621.791.75.011:[621.774.1:621.74.042]:669.14.018.44

STRUCTURE AND PROPERTIES OF CENTRIFUGALLY CAST THIN-WALL PIPE OF 40KhN35BS, 40KhN48V and 15KhN34B ALLOYS FOR REFORMER WELDED UNITS

Kiev AVTOMATICHESKAYA SVARKA in Russian No 7, Jul 85 pp 31-32

BEGMA, D. G., PISHCHIK, N. S., Deceased, Candidates of Technical Sciences, and GRZHEBALSAYA, V. N., Engineer, All-Union Scientific Research and Design-Technological Institute of the Pipe Industry

[Abstract] The authors' institute has developed a production technology and manufactured pipe specimens 162-226 mm in diameter, with wall thickness 13-16 mm and length 2700-4000 mm, from the alloys mentioned in the title. To evaluate the quality of these pipes and compare them to foreign specimens, studies were performed on pipe of similar composition manufactured in West Germany. The strength and ductility of the Soviet pipe were found to satisfy the German standards. The long-term strength of the pipes was equal to world standards, and heat resistance was superior to the German pipe samples. It was found possible to produce welded joints equal in strength to the parent metal. A technology has been developed for welding the pipe using domestic welding materials. The technology is not described in this article.

[24-6508]

UDC: 621.791.75.042.669.14.018.14

TYPE OZL-38 ELECTRODES FOR WELDING OF HEAT-RESISTANT STEELS

Kiev AVTOMATICHESKAYA SVARKA in Russian No 7, Jul 85 pp 36-37

YAROVINSKIY, Kh. L., STROYEV, V. S., Engineers, SIDLIN, Z. A., Candidate of Technical Sciences, Moscow Experimental Welding Plant

[Abstract] Tests of series-produced electrodes showed that the greatest resistance to formation of hot cracks and best high-temperature strength were obtained in joints made with KTI-7A electrodes, which unfortunately yield joints with the worst heat (hot oxidation) resistance. These electrodes can therefore be used for welding of the joints, but cladding layers should be applied with OZL-35 (10Kh27N68G2YuM2) electrodes, which have superior heat resistance. Acceptable high-temperature strength and heat resistance of welded joints can be obtained by the use of electrodes

with composition similar to the parent metal, 30Kh24N24B steel. Such electrodes were produced using standard wire with reduced carbon content--Sv-13Kh25N18. The method of introducing carbon from the coating of the electrode to the surfaced metal significantly influences the properties of the metal. Addition of graphite to the coating cannot be recommended, since carbon distribution is nonuniform in this case, thus reducing the long-term strength of the seam. Stable properties were achieved by the use of carbon-containing ferrochrome.

[24-6508]

UDC: 621.791.75.042:669.14.018.44

TYPE OZL-39 ELECTRODES FOR WELDING OF HEAT-RESISTANT STEELS FOR USE IN CARBONIZING MEDIA

Kiev AVTOMATICHESKAYA SVARKA in Russian No 7, Jul 85 pp 37-38

KAZIYEV, Ch. K., Engineer, Moscow Experiment Welding Plant

[Abstract] Studies were performed to determine the tendency toward embrittlement of existing electrodes and develop new electrodes for welding of heat-resistant steels for use in carbonizing media. Tests were performed in an industrial furnace during gas carburization of bearing rings at 940°C with a carbon potential of the gas of 0.9%. Impact bending test specimens, cut from the surfaced metal, were held in this medium for 1500 hours, along with steel specimens of the same shape. The specimens were then broken and their impact toughness before and after carburization compared. Severe embrittlement of both the steels and the metal surfaced by series-produced electrodes was revealed. The least embrittlement was observed in type 20Kh25N20S2 steel, apparently due to the protective effect of the silicon it contains. Type 20Kh23N18 steel is not suitable for use in such media, its impact toughness dropping to 10 J/cm<sup>2</sup> in just 500 hours. Type OZL-39 electrodes have now been developed, allowing the production of high-quality seams which can withstand long-term exposure to carbonizing atmospheres. References 4: all Russian.

[24-6508]

INFLUENCE OF STRUCTURE OF CAST NICKEL ALLOYS WITH GOOD HIGH-TEMPERATURE STRENGTH ON WELDABILITY AND MECHANICAL PROPERTIES

Kiev AVTOMATICHESKAYA SVARKA in Russian No 7, Jul 85 pp 39-41

KOTOV, V. F. and MARESEV, M. I., Candidates of Technical Sciences, MAKHNEVA, G. A., Engineer, SHVARTS, V. I., Candidate of Technical Sciences, Moscow; YUSHCHENKO, K. A., Doctor of Technical Sciences and PINCHUK, N. I., Candidate of Technical Sciences, Kiev; ROVENSKIY, I. L., Candidate of Technical Sciences, Kharkov

[Abstract] Studies of the weldability of nickel alloys with good high-temperature strength containing 6% Al showed that those with directed crystallization had higher cracking resistance than those produced by the ordinary method with equiaxial structure. In an alloy containing 6% Al cast by the ordinary technology, the  $\gamma'$  phase is segregated as arbitrarily distributed dispersed particles. In the same alloy with directed crystallization, the  $\gamma'$  phase orientation is primarily in the direction of crystallization. Carbides are segregated primarily parallel to the axis of the dendrites, with very few in the space between dendrites. High temperatures cause coagulation and dissolution of the  $\gamma'$  phase one-half as fast in the alloys following directed crystallization as in alloys produced by traditional methods. The short-term strength and yield point of the alloy are approximately the same in both cases. At test temperatures over 800°C, the columnar structure alloy loses less strength than the equiaxial structure alloy. Directed crystallization is particularly effective in increasing ductility. Long-term strength is greater in directed crystallization alloys, the increase being greater at higher temperatures and longer test times.

Reference 1: Russian.

[24-6508]

/9835

UDC 622.361.1

REFRACTORY CLAYS IN BALAKOVO DEPOSIT

Moscow OGNEUPORY in Russian No 8, Aug 85 pp 26-31

KATORGIN, G. M., POMERANETS, N. R. and MYZNIKOVA, L. M., All-Union Institute of Refractory Materials

[Abstract] Clays in the Balakovo deposit are a part of the 2.5 km long and 0.45-1.2 km wide kaolinitic bed at the Tula lower-carbon level, its depth increasing from 65 m at the southern end to 98 m at the northern end. Keolinitic clays with some mica-hydromica and up to 4% iron oxides (hematite) constitute 95% of the total clay volume. Its four grades BLPS0 (extra), BLPS1 (first), BLPS2 (second), BLPS3 (third) yield, respectively, 42.6%, 11.2%, 27%, 14% useful refractory material, as do correspondingly the four grades of pure kaolinitic clay BLS0, BLS1, BLS2, BLS3. The total content of oxides of alkali metals and alkali-earth metals does not exceed 1.5% in any of the grades. With respect to grain size fractions, all Balakovo clays including also plastic clays and arenaceous clays with 4-5% iron oxides and up to 2.7% oxides of alkali metals and alkali-earth metals range from medium-disperse (up to 80.3% of <0.01 mm fraction with up to 69.5% of <0.001 mm fraction) to fine-disperse (up to 99.4% of <0.01 mm fraction with up to 77.5% of <0.001 mm fraction). Kaolinitic and pure kaolinitic clays in the Balakovo deposit are characterized by large air shrinkage and high total water content, moderate plasticity and binding ability. Both BLPS0 and BLS0 grades are highly refractory (1750°C or higher), after roasting at 1300-1320°C, sinterable to a less than 5% water absorption.

[247-2415]

UDC: 669.2/.8

PRESENT AND FUTURE OF A NORTHERN GIANT

Moscow TSVETNYYE METALLY in Russian No 8, Aug 85, pp 30-34

FILATOV, A. V.

[Abstract] The Norilsk Mining and Metallurgical Combine is fifty years old. The history of the combine is briefly outlined. Technical achievements of the past are mentioned, and challenges for the future are discussed. Recent achievements include the introduction of the Talnakhskaya Beneficiation Plant and the Nadezhdinskiy Metallurgical Plant. The volume of production of nickel has increased by a factor of 1.4, of copper and cobalt by 1.5 times during the eleventh Five Year Plan alone. In 1984, the combine fulfilled its labor productivity plan by 101%, while decreasing the cost of commodity output by 2%. Irrecoverable losses of metals with waste have been reduced. Such processes as suspended melting of copper and nickel concentrates, melting of nickel-containing copper raw materials in a liquid bath furnace, autoclave oxidative leaching with distributed slurry feed in a 125 m<sup>3</sup> autoclave and melting of concentrates with a blast enriched to 40-50% oxygen have been introduced. Pressing problems for the future include development of methods of diagnosis and testing of the stress-strain state of a rock mass, methods of controlling rock pressure in mine workings, development of effective technological processes for extraction in mines, installation of large capacity equipment at beneficiation plants, production of carbon-containing and fluxed sinter, improved dust trapping and water utilization at the sinter plant, development of sealed or heating and beneficiation furnaces at the nickel plant, introduction of a technology for melting copper in a liquid bath furnace with waste recycling, elimination of accumulation of metals in recycled slag at the Nadezhdinskiy plant and utilization of sulfur from stack gases.

[16-6508]

UDC: 669.33+669.243

ELECTRIC MELTING OF COPPER-NICKEL SINTER PRODUCING SLAG SUITABLE FOR REPLACEMENT OF CEMENT CLINKER

Moscow TSVETNYYE METALLY in Russian No 8, Aug 85, pp 34-35

GRAN, N. I., MOSIONDZ, K. I., BERMAN, V. S., SHAMRO, E. A., BOZHENOV, P. I. and GRIGORYEV, B. A.

[Abstract] The task of producing slag of a composition satisfying the requirements of metallurgical production as well as the requirements for subsequent use of the slag in the economy, as for cement clinker, directly in the main technological process, is a difficult one, requiring the efforts of specialists from various areas of technology. Copper-nickel slag to be

used to replace clinker must have the maximum vitreous structure,  $27+1\%$  CaO content and specific ratios of CaO to  $SiO_2$ , total iron, MgO and  $Al_2O_3$ . One electric furnace of the Norilsk Mining and Metallurgical Combine nickel plant has undertaken production of copper-nickel sinter based on lime slag containing over 26% CaO with subsequent aqueous granulation of the slag. The slag has been used to produce a binder with a new composition as well as mine stowing mixtures based on the binder. The stowing mixtures were found to be stronger than specimens made of ordinary binder containing 95% cement clinker. References 7: all Russian.

[16-6508]

UDC: 669.295

#### TRENDS IN CORROSION CONTROL OF TECHNOLOGICAL METALLURGICAL EQUIPMENT AT NORILSK COMBINE

Moscow TSVETNYYE METALLY in Russian No 8, Aug 85, pp 45-48

TRAVNICHEK, I. A.

[Abstract] Corrosion testing has shown that in most corrosive media found in the hydrometallurgical processes at the Norilsk Combine, technical titanium and its alloys have the greatest corrosion resistance. Chrome-nickel austenitic steels and alloys can be used in a number of processes. Some equipment such as the aspiration systems at the sinter plant or the roof of the melting shop must operate in sulfur-containing media with condensing humidity. The only structural metal capable of withstanding these conditions is titanium and its alloys. The equipment used in high temperature roasting processes in erosive sulfur-containing concentrates can be made of nickel-free chrome alloys. Further studies are needed to determine the limits of corrosion resistance of chrome alloys under high temperature gas corrosion conditions in sulfur-containing media, to increase the erosion resistance of titanium units and parts by carbidization and surfacing with titanium carbides, to introduce organizational and technical measures guaranteeing high quality of welds, to study utilization of titanium wastes as fasteners with surface carbidization to increase antifriction properties, to determine the corrosion resistance in actual areas of applicability of nickel-free and low-nickel alloys, to introduce means for protection of titanium equipment from electro-corrosion, and to test and introduce methods of protection of titanium from hydrogen embrittlement for use in nickel electrolysis equipment as cathodes by means of special electrochemical treatment.

[16-6508]

UDC: 669.713.7

EXPERIMENTAL ESTIMATE OF MEASUREMENT OF ALUMINUM ELECTROLYZER BACK EMF

Moscow TSVETNYYE METALLY in Russian No 8, Aug 85, pp 64-66

GROMYKO, A. I., ZALIVNOY, V. I., ANISOV, S. P. and BRATIK, S. A.

[Abstract] Experimental studies were performed on the electrolyzers of the Krasnoyarsk Aluminum Plant. The results of measurement of back EMF by indirect and direct measurements with the current disconnected were compared. The indirect method used was the harmonic method. Ten minutes before a current decrease in the series the back EMF was determined by the harmonic method by measurement of effective current and voltage of the harmonic components in the current. The harmonic method of measurement of back EMF yielded approximately the same error as the method of disconnection of current by stages. The advantage of the harmonic method is that it has no influence on the technological process. The experiments confirm the possibility of using the harmonic method for determination of back EMF.

[16-6508]

UDC: 669.295

METALLOTHERMIC PRODUCTION OF ALLOYED TITANIUM

Moscow TSVETNYYE METALLY in Russian No 8, Aug 85, pp 84-91

SANDLER, R. A., Deceased, ZAKHAREVICH, A. A. and GOLUBEVA, O. A.

[Abstract] This literature review discusses the production of titanium alloy. A homogeneous titanium alloy of the required composition can be produced by mixing all of the initial substances before they are introduced into the reactor, or as they are introduced into the reactor, if conditions are provided which prevent loss of homogeneity of the mixture during the process of metallothermic reduction. The production of uniformly alloyed titanium sponge by traditional methods is quite difficult due to the formation of intermetallides with significant Gibbs energy. The use of solutions with mutually unlimited solubility such as  $TiCl_4 + VCl_4$  and  $TiCl_4 + SnCl_4$  allows the production of uniformly alloyed titanium. Joint metallothermic reduction of chlorides from melted mixtures is based on the reduction of the chlorides of titanium and its alloying elements from melts prepared on the basis of alkali-alkaline earth metal chlorides. The main advantage of this method is the ability to produce multicomponent melts with regulated ratios of titanium to alloying elements. Conditions are listed which prevent changes in the calculated composition of the melt. The major factor causing organizational and technical difficulties is the broad range of titanium alloys produced in the USSR. The authors call for a reduction in the length of this list. References 32: 31 Russian, 1 Western.

[16-6508]

DECREASING LOSS OF MOLYBDENUM IN BENIFICATION

Moscow TSVETNYYE METALLY in Russian No 8, Aug 85, pp 118-120

AKKERMAN, Yu. E. and STRELSKAYA, L. A.

[Abstract] Mineralogic testing of the fraction smaller than 1 mm in diameter extracted from an ore crusher revealed that molybdenum is found in this product both as free grains and in various concretions. In the -0.15 mm fraction, concretions are much less frequent. This served as a basis for a study of the desirability of separating the finer classes of crushed ore to be sent on to flotation without grinding. Two series of laboratory experiments were performed. In series one, the -0.15 mm class was washed from the crushed ore and then the remaining ore was ground to 40, 50 and 55%-0.071 mm. Then the -0.15 mm class was added, and the mixture was sent to flotation. Best benification results were achieved with finer grinding of the stronger rock and coarser grinding of the brittle and softer rock. The increase in extraction of Mo was 1.7-3.4%. Selective grinding of classes of crushed ore to different final particle sizes was found to have a positive effect, manifested as an increase in benification results due to the more favorable distribution of the extracted component among the particle size classes.

[16-6508]

/9835

## MISCELLANEOUS

### NEW MATERIALS, INSTRUMENTS DEVELOPED

Moscow ZNANIYE-SILA in Russian Vol 698, No 8, 1985, p 3

#### [Excerpt] Faster, Ever Faster

Molecules and atoms move uniformly in melted metals and semiconductors. When melts cool, the rate of diffusion gradually decreases during crystallization, and some chemical inhomogeneities necessarily appear. Cooling alloys from into individual layers because the motion of the molecules of different metals slows down at different rates as temperature decreases.

Recently Soviet scientists proposed a procedure for cooling an alloy "in the blink of an eye." The temperature of the sample drops at a rate of over a million degrees per minute! At this fast cooling rate, the atoms in the melt distribute themselves uniformly as in a liquid.

A chamber filled with pure argon maintained at high pressure is used in a device created by the Moscow Institute of Electronic Engineering. In this chamber, a jet of melted metal is poured into a copper cylinder which rotates at a velocity of 8,000 rpm, and which vibrates as it rotates. On coming in contact with this cylinder, the melt cools instantaneously. Many ultra-uniform materials have already been obtained by this method.

#### Ultrasonic Blacksmith

Extremely thin flat springs can be found in almost every instrument. Instrument precision depends in many ways on the precision of the springs. Tens of thousands of such minute springs are manufactured by a complex procedure requiring a jeweler's precision.

First a wire is flattened into a band, usually by rolling in miniature multi-roller rolling mills. Then the band is wound onto a shaping cylinder by a precision coiling machine, after which the spring is ground across its diameter and roated. But try as we may with equipment of the greatest precision, the coil, which must be strictly rectangular in cross section, never does achieve this quality. And warped coils are useless to an ultra-precise instrument, since their electrical, mechanical, magnetic and some other properties are indefinite. The problem is that it is impossible to make

the dimensions of the initial band precise because when wire is rolled into a band, not only the wire but also the rollers themselves are deformed. When bands are made from solid metals and alloys, and when most such bands are coiled for use in precision instruments, enormous unit pressures arise in the deformation zone, and before flattening down a wire a hundredth or even half a hundredth of a millimeter thick creates, by its rounded edges, a depression in the rollers compressing it; consequently it emerges from the rollers not with strictly parallel surfaces but rather with convex surfaces.

This difficult problem was solved by Saratov engineers G. O. Volk, A. P. Ilin and others. Rather than trying to improve the existing procedure, which consists of many stages, they made a flat coil right away, in a single operation, out of round wire.

The miniature smithy worked in the following way. A turning shaping cylinder wound round wire onto itself. An ultrasonic magnetostriction vibrator with a head resembling that of a forging hammer was installed over the form. The up-and-down motion of the hammer head was measured not in the centimeters, and not even in the millimeters, but rather in the tens of microns. But it struck the wire 20,000 times a second. This transformed the round wire into a coiled flat band of ideal, totally undistorted shape.

There is one more advantage: The deviation in the thickness of the band does not exceed several microns, and therefore final grinding of the coils is not required.

#### Digital Program Control for a Spark

We are standing in the exhibition hall of the Experimental Scientific Research Institute of Machine Tools.

"Consider how quiet it is in the hall," said Candidate of Technical Sciences A. B. Sosenko. "Imagine how much noise there would be here if ordinary machine tools--milling machines, drills, lathes--were working here instead of noiseless electro-erosion tools. But of course the advantage of our machine tools lies not only in this but also in their unusual possibilities."

An electro-erosion cutting tool with digital program control is operating before us. The word "cutting" involuntarily brings up an image of a gas cutter or milling cutter with sharp teeth to mind. But here metal is being cut by a wire a little thicker than a human hair; thousands of electric sparks jump between it and the metal being processed. One would think that the wire would burn, vaporize instantaneously, like a wire fuse in response to a short circuit. But in the same way that a scroll saw cuts plywood, this wire just keeps on cutting through the hard alloy plate. The wire travels along a prescribed contour with a characteristic crackling sound, cutting a hairline slot through the blank. There is no other method for performing this operation.

Another machine tool makes molds with which to manufacture rubber boots. The principle is the same: Electric discharges melt the surface of the

metallic blank and erode out metal particles, which a flow of cooling liquid transforms into a powder and removes from the working zone. But in this case the electric discharges arise not along the wire, as with cutting, but rather over the entire surface of the electrode, which is shaped into the form of a boot. And this electrode leaves an imprint in the massive slab of stainless steel as if it were soft clay. It takes several days to prepare such a mold using conventional procedures. Here it is obtained in a few hours. In this case the designer of a new style of rubber footwear can first embody his idea in a plaster model. In the new procedure, a layer of copper is simply sprayed onto this model, which results in the electrode that is used to make the mold for the boots. The same method is used to make intricate molds, for example to stamp crankshafts, and to cast glass with an intricate, precise pattern for motor vehicle headlights.

Electro-erosion processing, the list of possibilities of which would take up several pages, is perhaps the most progressive procedure in machine building today. Its further development is foreseen by one of the integrated programs of the USSR State Committee for Science and Technology. Specialists believe that in instrument making, as an example, electro-erosion technology should be used in not less than 40 percent of all ordinary processing of steel, and 80 percent in the processing of hard alloys.

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